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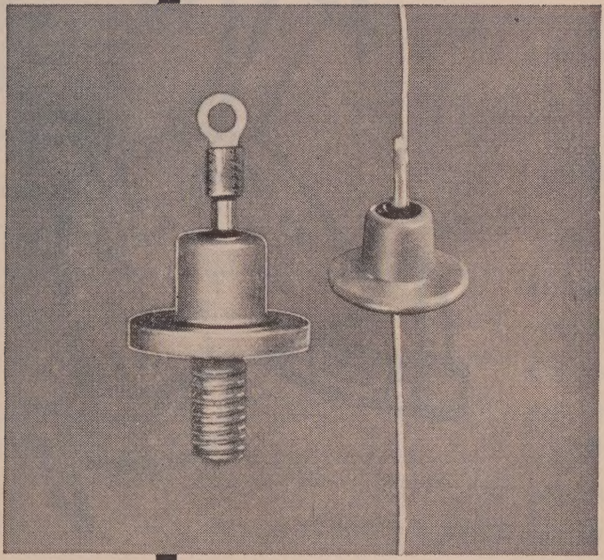

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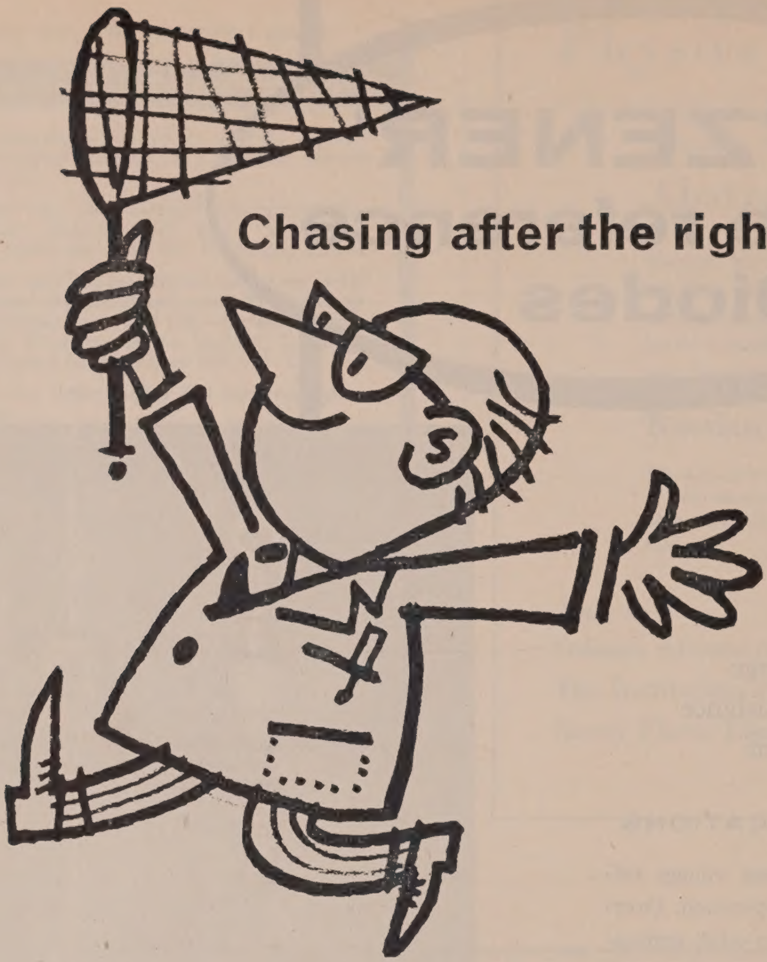

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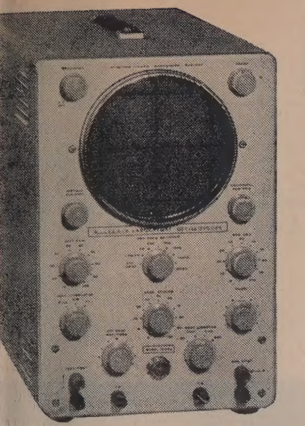
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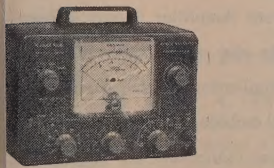
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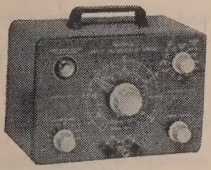
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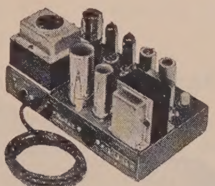
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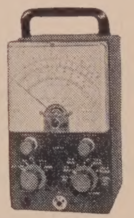
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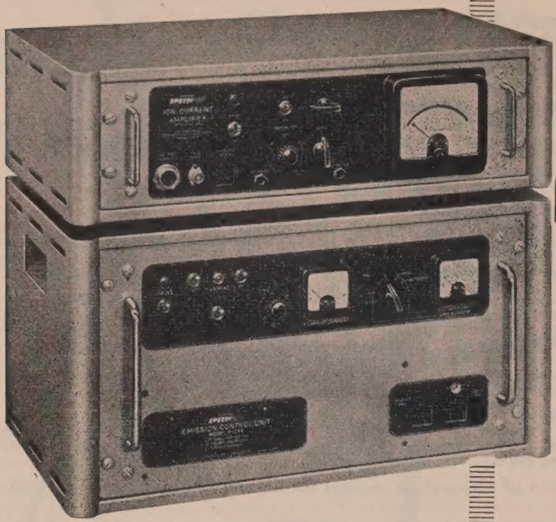

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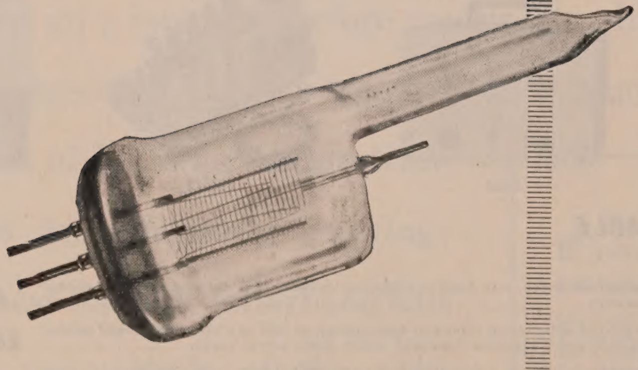
Intended basically for use with the "Speedivac" IG-3 series ultra high vacuum ionisation gauge heads, the "Speedivac" Emission Control Unit Model 1 and the Ionisation Current Amplifier Model 2 have been designed to provide also maximum versatility for general low current ionisation investigations, and other applications where emission controlled outputs and high sensitivity current indications are required.

The outstanding feature of this new ionisation gauge control system when used with an IG-3 gauge head is that pressures down to the soft X-ray limit, about 5×10^{-11} torr for this type of head, can be measured with only 10 μA emission current thus reducing to a new low level the risk of inaccuracy due to local ion pumping action by the gauge head. The extreme sensitivity of the "Speedivac" system permits nominal pressure changes of 5×10^{-13} torr to be indicated with the higher emission currents available.



Top: Ion current amplifier and emission control unit mounted together in standard 19 ins. P.O. racks.
Lower: IG3H hard glass ultra high vacuum gauge head.

★ Torr = mm Hg (B.S.2951—1958).

EDWARDS HIGH VACUUM LTD., MANOR ROYAL, CRAWLEY, SUSSEX, ENGLAND. *Crawley 150*

PHYSICS ABSTRACTS

olume 63 SEPTEMBER 1960 Number 753

MATHEMATICS

511

12232 FRONTIERS OF NUMERICAL MATHEMATICS.
Edited by R.E.Langer.
adison, Wisconsin: The University of Wisconsin Press (1960)
2 pp. [Publication Number 4 of the Mathematics Research Center,
ited States Army, The University of Wisconsin].

Eight papers of a symposium conducted by the Mathematics
esearch Centre, U.S.Army at the National Bureau of Standards at
e University of Wisconsin, October 1959. The titles are as follows:
ress Analysis in the Plastic Range; Some Mathematical Problems
Nuclear Reactor Theory; Numerical Problems of Contemporary
lestial Mechanics; Aeroelasticity; Operations Research;
athematical Bottlenecks in Theoretical Chemistry; Magnetohydro-
namics; On the Application of Numerical Methods to the Solution
Systems of Partial Differential Equations Arising in Meteorology.
stracts of these papers will be found in this or succeding issues of
ysics Abstracts.

517

12233 ON THE SOLUTION OF AN EIGENVALUE EQUATION OF THE WIENER-HOPE TYPE IN FINITE AND IN-
NITE RANGES. R.Mittra.
ppl. sci. Res. B, Vol. 8, No. 3, 201-7 (1960).

A formulation is presented of the eigenvalue matrix equation of
e Wiener-Hopf integral equation defined in finite and infinite
nges. The method provides a simple means for obtaining the
genvalue equation and indicates a way for obtaining the eigen-
nctions and the eigenvalue. This direct formulation is helpful in
e solution of inhomogeneous Wiener-Hopf equations in finite and
finite ranges.

517

12234 SOME REMARKS CONCERNING THE REAL AND IMAGINARY PARTS OF THE CHARACTERISTIC ROOTS OF A FINITE MATRIX. D.C.Lewis, Jr and O.Taussky.
J. math. Phys. (New York), Vol. 1, No. 3, 234-6 (May-June, 1960).

Some theorems are obtained on the existence of certain determinantal equations whose roots are separately the real or imaginary parts of the characteristic roots of a given matrix with simple elementary divisors. When the elementary divisors are not simple, similar, but somewhat less precise, results are obtained.

517 : 530.16

INVERFC θ: PROPERTIES, DERIVATIVES AND INTEGRALS. See Abstr. 12368

518 : 536.2

PROPAGATION OF ROUND-OFF ERRORS IN THE NUMERICAL INTEGRATION OF THE HEAT EQUATION. See Abstr. 12508

518 : 621.374.32

12235 LARGE STORAGE BINARY-TO-DECIMAL CONVERTER.
G.Dearnaley, L.G.Lawrence and H.C.Tresise.
J. sci. Instrum., Vol. 37, No. 7, 240-2 (July, 1960).

An accurate binary-to-decimal converter is described capable of dealing with numbers up to 2^{24}. The instrument is designed for manual input with display on dekatron indicators, and a speed of operation of four bits per second.

519 : 539.2 : 548.7

METHOD TO OBTAIN THE CHARACTER TABLES OF NON-SYMMORPHIC SPACE GROUPS. See Abstr. 12024

ASTROPHYSICS

522.1

12236 THE OBSERVATORY IN SANTIAGO.
F.Rutllant.
stron. J., Vol. 65, No. 4, 193-4 (May, 1960).

The historic background of the 111 year-old observatory at
ntiago, Chile, is reviewed with respect to its instruments, staff,
ogrammes, and plans in its new location.

522.1

12237 NOTES ON THE SOUTHERN STATION OF LA PLATA OBSERVATORY AND ON FUTURE ASTROMETRIC
ORK IN THE SOUTHERN HEMISPHERE. S.J.Slaucitajs.
tron. J., Vol. 65, No. 4, 195 (May, 1960).

The Southern Station of the La Plata Observatory at Santa Cruz
planned for fundamental astrometric observations from a high
uthern latitude. In order to further meridian circle observations
the southern hemisphere, it is necessary to establish a committee
r the unification and distribution of meridian circle work at
fferent Observatories in accordance with their capacities.

522.1

12238 PERTH OBSERVATORY.
H.S.Spigl.
stron. J., Vol. 65, No. 4, 196 (May, 1960).

The equipment and work of the Perth Observatory is briefly
escribed.

522.1

12239 REPORT ON THE CAJIGAL OBSERVATORY.
J.Abdala.
stron. J., Vol. 65, No. 4, 522-1 (May, 1960).

522.1

12240 OBSERVATORY AT SAN JUAN.
J.Nissen.
Astron. J., Vol. 65, No. 4, 198 (May, 1960).

The plans of the Observatory at San Juan are described briefly.

522.2

12241 THE BERGEDORF 32" CONVENTIONAL SCHMIDT TELESCOPE AS AN ASTROMETRIC INSTRUMENT.
W.Dieckvoss.
Astron. J., Vol. 65, No. 4, 214-17 (May, 1960).

Measures of 145 stars on four Schmidt plates were used for comparison with good astrographic positions to test a formula of Brosterhus that corrects the measured coordinates for effects of the bending of the plate during exposure. While the overall suitability of large fields seems to be promising up to a mean error of ±0″.10 in position, only much more extensive tests can give definite results for higher precision.

522.3

12242 PROBLEMS OF DIVIDING ACCURATELY THE CIRCLES OF MERIDIAN INSTRUMENTS. A.Danjon.
Astron J., Vol. 65, No. 4, 227-8 (May, 1960).

A new method of engraving lines on standard metres is described. It is proposed that a similar method be used for the circles of meridian instruments.

522.5

12243 THE AUTOMATIC GUIDER OF THE DOMINION ASTROPHYSICAL OBSERVATORY. P.E.Argyle.

Publ. Dominion Astrophys. Obs, Victoria, B.C., Vol. 11, No. 7, 201-8 (1960).

An automatic photoelectric guider has been built and installed on the spectrograph of the 72 in. telescope. It utilizes a single photomultiplier and a rotary chopper to sense guiding errors. It has operated satisfactorily on stars as faint as the 11th magnitude.

522.6

12244 AUTOMATIC MEASUREMENT OF ASTROGRAPHIC PLATES. S.Vasilevskis.

Astron. J., Vol. 65, No. 4, 208-12 (May, 1960).

An outline is given of the equipment for the survey and automatic measurement of astrographic plates taken for the Lick Proper-Motion Programme. The equipment is at the initial stage of development and manufacture by the Gaertner Scientific Corporation, Chicago, in accordance with Lick specifications of performance and precision. Possibilities of using similar or simplified equipment for other astronomical problems are also indicated.

522.6

12245 THE USE OF A VERY WIDE ANGLE CAMERA FOR CATALOGUE WORK. D.Brouwer.

Astron. J., Vol. 65, No. 4, 228-9 (May, 1960).

It is proposed to experiment with the use of cameras covering fields of 15° by 15° or 20° by 20° on 17 × 17 in. plates for the measurement of the reference stars observed with meridian circles. The object would be to smooth out the errors in the reference system, reduce the number of meridian circle observations, or make it possible to concentrate the meridian circle observations on fewer stars. The flatness requirements will be more severe than for plates covering smaller fields. Also, the reduction may present new problems.

523

12246 NEW SET OF VARIABLES FOR ASTRONOMICAL PROBLEMS. A.M.Garofalo.

Astron. J., Vol. 65, No. 3, 117-21 (April, 1960).

The equations of motion for a particle A under the gravitational influence of n other particles in a system of reference with origin at one of these particles B are written in terms of new variables. These have the classical property of being constant if one considers only the influence of B on the motion of A. In addition they have the advantage of not introducing any new singularities if the instantaneous conic of A relative to B does not degenerate into a straight line.

523.1

12247 COMMUNICATIONS FROM SUPERIOR GALACTIC COMMUNITIES. R.N.Bracewell.

Nature (London), Vol. 186, 670-1 (May 28, 1960).

If advanced societies superior to ourselves in technological development exist then it is considered that rather than maintain a large number of powerful transmitters in the search for other advanced communities they are more likely to have sent probes to nearby stars. The possibility of an advanced culture within reach of the solar system is discussed and also the means of recognizing and communicating with any probes in our neighbourhood.

C.Hazard

523.1 : 538.3

FORCE-FREE MAGNETIC FIELDS. See Abstr. 12689

523.11

12248 THE ENERGY BALANCE OF OPAQUE ATMOSPHERES. J.B.Zirker.

Astrophys. J., Vol. 131, No. 3, 684-9 (May, 1960).

Expressions for the net loss of radiative energy as a function of depth in an opaque atmosphere are developed. The theory takes into account the transfer of radiation through atmospheres whose hydrogen and helium excitation departs from thermodynamic equilibrium. The temperature-dependence of the energy loss from uniform model chromospheres is calculated.

523.11

12249 THE SOURCE FUNCTION IN A NON-EQUILIBRIUM ATMOSPHERE. V. CHARACTER OF THE SELF-REVERSED EMISSION CORES OF Ca$^+$ H AND K.

J.T.Jefferies and R.N.Thomas.

Astrophys. J., Vol. 131, No. 3, 695-704 (May, 1960).

For Pt IV see abstr. 6606 of 1960. The methodology of Pt III (see abstr. 11744 of 1959) is applied to delineate the principal parameters affecting the characteristics of the self-reversed emission cores Ca$^+$ H and K, in order to clarify whether current discussions in te only of $\Delta\lambda_D$ are adequate. Two additional factors are found to be significant — ϵ and the T_e gradient. The factor ϵ provides an effect in the correct direction to interpret the Wilson—Bappu effec but of too small a size, subject to a more complete treatment of th region outside the Doppler core. The effect of the T_e gradient seems more significant, particularly as a basis for interpreting th observed solar variations.

523.

12250 ON THE POSSIBILITY OF OBSERVING INTERSTELL ALUMINUM. A.Burgess, G.B.Field and R.W.Michie.

Astrophys. J., Vol. 131, No. 3, 529-36 (May, 1960).

Of the interstellar ions which might be expected to be observe only Al^0, Co$^+$, and Ni$^+$ remain undetected. Theoretical estimates the equivalent widths of λ 3944 of Al I in the spectra of χ^2 Ori and ζ Per have been made, using a photoionization cross-section deriv by the quantum-defect method. The predicted width in ζ Per is between 0.9 and 2.7 mA, depending on the importance of autoioniza these values are not inconsistent with a recent observational uppe limit. An appendix treats quantitatively the excitation of fine structure in interstellar space. While the results indicate that ev very low-lying levels, such as that of Al^0, are strongly depopulate attention is drawn to the importance of excitation by collisions wit H atoms.

523.1

12251 ON THE STABILITY OF IONIZATION FRONTS. F.D.Kahn.

Rev. mod. Phys., Vol. 30, No. 3, 1058-61 (July, 1958).

The author considers the stability, with respect to corrugatio of ionization fronts which are backed by a vacuum and with are ad cing into a cold, non-ionized gas. The only type found to be unsta is a D-critical I front (for terminology, see Abstr. 10525 of 1960) which the intensity of ionizing radiation is increasing with time. instability is not likely to be important in practice, because of the strong damping effect due to the absorbtion of radiation in the bri rim following the front. The formation of "elephants' trunks" is therefore probably due to some other effect, possibly an unevenne in the distribution of neutral interstellar matter in the vicinity of O stars.

O.Penr

523.

12252 SPECTRAL MEASUREMENTS IN RADIO-ASTRONOM É.J.Blum.

C.R. Acad. Sci. (Paris), Vol. 250, No. 20, 3279-81 (May 16, 1960). In French.

General outline of a method for hydrogen line observations analogous to interferometer methods used in optical spectroscopy The amplified signal is directed into two paths, each of which has large number of output channels. By the introduction of suitable delays into one set of output channels the correlation function of the signal can be found and hence by a Fourier transform the spectrum of the signal. The advantages over a conventional multi channel equipment are discussed.

C.Haza

523.16 : 621.396.9

12253 EXTRATERRESTRIAL NOISE AS A FACTOR IN SPAC COMMUNICATIONS. A.G.Smith.

Proc. Instn. Radio Engrs, Vol. 48, No. 4, 593-9 (April, 1960).

The various cosmic and solar system radio sources are considered with respect to their intensities, spectral distributions and temporal characteristics. The most severe forms of interference occur in the long-wave length regions of the radio-freque spectrum, so that the future of space communications probably lie in the perfecting of low-noise microwave systems.

523.

12254 POLARIZATION AND ANGULAR EXTENT OF THE 960 Mc/sec RADIATION FROM JUPITER.

V.Radhakrishnan and J.A.Roberts.

Phys. Rev. Letters, Vol. 4, No. 10, 493-4 (May 15, 1960).

Using a variable spacing interferometer, it has been shown th the radiofrequency radiation from Jupiter is strongly linearly pol ized with the electric vector parallel to the equatorial plane of the planet. The diameter of the radio source is several times the dia meter of the visible disk and the radiation is more strongly polari zed in the outer regions. The observations suggest that either the cyclotron or synchroton mechanisms apply. As in the cyclotron se the polarization will change rapidly with frequency while in the nchroton case no rapid change is expected, observations of polari- tion and source size as a function of frequency should provide a thod of discriminating between the two theories.

C.Hazard

523.16

12255 THE ASSOCIATION OF SOLAR RADIO BURSTS WITH FLARES AND PROMINENCES.

Swarup, P.H.Stone and A.Maxwell.

trophys. J., Vol. 131, No. 3, 725-38 (May, 1960).

Solar radio bursts in the frequency range 100-580 Mc/s have en correlated with solar optical phenomena over a 2-year period vering the present sunspot maximum. It is found that 60% of st-drift (type III) radio bursts are coincident in time with solar ires. This figure is in accord with that obtained by previous vestigators, but statistical studies show that only half this number bursts are truly associated with flares: the remainder are sociated by chance. The truly associated bursts usually occur tween the start and the maximum of a flare. Intense bursts are ore highly associated with flares than are weak bursts. In the verse correlation — that of flares with radio bursts — it is found at 25% of all solar flares are apparently associated with fast-drift rsts, the probability of association increasing if the flare is of eater area or height, on the east side of the disk, or accompanied a surge or spray. Almost all slow-drift bursts (type II) and ntinuum (type IV) events are associated with flares, often of large ea and intensity, but there is no well-defined association between ise-storm bursts (type I) and flares. Only a small proportion of ective solar prominences are accompanied by radio bursts; this ay result from the unfavorable geometry for radio propagation om the limb. Concerning the physical association of the flares and lar bursts, it is suggested that both phenomena result from an identified primary origin. The transfer of energy to coronal radio vels probably takes place at 10^5 km/sec in the case of the fast- ift bursts and at about 10^3 km/sec for the slow-drift bursts.

523.16

12256 VARIATIONS IN THE SOLAR BASE LEVEL RADIATION ON 200 Mc/s. Ø.Hauge.

trophys. Norveg., Vol. 6, No. 11, 123-30 (Jan., 1960).

The thermal base level emission from the sun in the 200 Mc/s nge shows a primary intensity variation which is closely connected th the sunspot cycle. The base level radiation at sunspot maximum on the average about twice the flux magnitude at sunspot minimum. nall, secondary variations in the emission do not seem to orginate areas on the sun giving enhanced noise storm emission, but appear be caused by local sources of enhanced temperature in the corona.

523.16 : 551.5

12257 A RELATION BETWEEN SOLAR RADIO EMISSION AND POLAR CAP ABSORPTION OF COSMIC NOISE.

.R.Kundu and F.T.Haddock.

ture (London), Vol. 186, 610-13 (May 21, 1960).

The use of polar cap absorption (ionospheric absorption of smic noise in polar regions), which is believed to be caused by nization of the upper atmosphere by fast protons (10-50 MeV) nitted from the sun after a big flare, as a detector of low-energy smic rays suggests the importance of identifying the nature of lar radio emission which might be associated with these absorption ents. In view of this the authors make a statistical study of the ture of centimetre-wave as well as metre-wave radio outbursts sociated with polar cap absorption events and draw general nclusions regarding the prediction of the proton events. The alysis includes the 31 events of polar cap absorption reported tween February 1956 and July 1959. For radio burst data the ngle frequency observations of the University of Nagoys on 9400, 50, 2000 and 1000 Mc/s, of Ottawa on 2800 Mc/s, and the dynamic ectrum records of the University of Michigan and the Harvard ation at Fort Davis in 100-600 Mc/s band and of Sydney in 40-240 c/s are used.

C.F.Barnaby

523.16 : 537.59

COSMIC-RAY STORMS AND SOLAR RADAR EMISSIONS.

e Abstr. 11254

523.16 : 621.391.812.63 : 621.396.969

12258 CHARACTERISTICS OF 488 MEGACYCLES PER SECOND RADIO SIGNALS REFLECTED FROM THE OON. B.C.Blevis and J.H.Chapman.

Res. Nat. Bur. Stand., Vol. 64D, No. 4, 331-4 (July-Aug., 1960).

Radio signals at 488 Mc/s, received after reflection from the moon, have been studied using a continuous wave bistatic radar system located near Ottawa, Canada. These experiments were carried out during 1957 and consisted of monitoring the signals received on two orthogonal dipoles mounted at the focus of a 28 ft parabolic tracking aerial. The total mean received signal yielded an effective radar cross-section of the moon at this frequency of 0.05 of the projected area. The libration fading as observed in the two orthogonal receiver channels was in synchronism, with a cross-correlation coefficient of 0.89. It was established that the signal is not depolarized significantly on reflection at the surface of the moon or in passing through the ionosphere. Rotation of the plane of polarization of the radio wave in the double passage through the ionosphere was observed to change by nearly 180° over a six-hour period during quiet ionospheric conditions.

523.16 : 551.5

RADIO EMISSION BY THE IONOSPHERE. See Abstr. 12180

523.16

12259 OBSERVATIONS OF THE REGION OF THE CENTRE OF THE GALAXY AT 33.3 cm WAVELENGTH WITH THE LARGE RADIOTELESCOPE OF THE CHIEF ASTRONOMICAL OBSERVATORY. V.G.Malumyan.

Dokl. Akad. Nauk SSSR, Vol. 129, No. 5, 1003-4 (Dec. 11, 1959). In Russian.

A further investigation of the Sag. A source, supplementing those already made by others (Abstr. 10483 of 1960) at different wavelengths.

G.A.Chisnall

523.16

12260 POSITIONS, INTENSITIES, AND SIZES OF BRIGHT CELESTIAL SOURCES AT A WAVELENGTH OF 10.2 cm.

R.M.Sloanaker and J.H.Nichols.

Astron. J., Vol. 65, No. 3, 109-16 (April, 1960).

The positions of eight bright discrete sources at 10.2 cm were measured to estimated accuracies of ±1' pe using the Naval Research Laboratory 84 ft aerial. The equivalent Gaussian diameters and flux densities were also determined.

523.16

12261 H-LINE PROFILES AT HIGH GALACTIC LATITUDES.

W.C.Erickson and H.L.Helfer.

Astron. J., Vol. 65, No. 1, 1-20 (Feb., 1960).

Profiles of moderate accuracy obtained in a survey of high-latitude hydrogen. A map of the distribution of galactic hydrogen is presented.

523.16

12262 A COMPOUND INTERFEROMETER.

A.E.Covington.

J. Roy. Astron. Soc. Canada, Vol. 54, No. 2, 58-68 (April, 1960).

The operation of a 10 cm interferometer (See Abstr. 4878 of 1960). is described. Daily observations on the sun indicate that the performance is satisfactory. The results suggest that the minimum dimension of solar radio emissive regions is of the order 1.5 min. of arc.

C.Hazard

523.2

12263 THE CORRECTION TO THE MOTION OF THE EQUINOX.

J.Schilt.

Astron. J., Vol. 65, No. 4, 218-21 (May, 1960).

Corrections to the planetary precession and to the motion of the equinox are studied under the assumption that the space velocity component perpendicular to the plane of the galaxy is, on the average, independent of the galactic longitude.

523.2

12264 THE ASTRONAUTIC CHART.

R.C.Spencer.

Proc. Inst. Radio Engrs, Vol. 48, No. 4, 528-31 (April, 1960).

The Astronautic Chart is a nomograph or alignment chart so arranged that a single straight line marks off values of the velocity, mass, mean distance, period, and acceleration of any two-body orbiting system. It is illustrated with numerous examples of orbits of planets about the sun, moons about their planets, and artificial earth satellites. All scales give correct values at the extremities of the minor diameter of the elliptical orbit. In the case of binary stars where the masses are comparable, the scales also give correct values of the total mass, total separation, relative velocity, and relative acceleration.

523.4

12265 MOTION OF JUPITER AND MASS OF SATURN.

G.M.Clemence.

Astron. J., Vol. 65, No. 1, 21-2 (Feb., 1960).

The discrepancy between theory and observation in the longitude of Jupiter found by Krotkov and Dicke, which has a coefficient of $0''.25$ and a period of 4520 days, is removed by attributing mass 1/3499.7 to Saturn and adding two known corrections to the motion of the perihelion.

523.4

12266 EPHEMERIS FOR PHYSICAL OBSERVATIONS OF JUPITER NEAR CONJUNCTION.

C.Krampe.

Astron. J., Vol. 65, No. 2, 104-6 (March, 1960).

The ephemeris for physical observations of Jupiter during the intervals near conjunction that are omitted from the American Ephemeris is given for 1960, 1961, and 1962, for the reduction of radio observations.

523.4

12267 THE SATELLITES OF THE PLANETS.

J.G.Porter.

J. Brit. Astron. Assoc., Vol. 70, No. 1, 33-42 (Jan., 1960).

A detailed account of the present knowledge of the natural satellites of the solar system. A chronological table of satellite discoveries, both visual and photographic, is included. D.R.Barber

523.5

12268 EFFECT OF ACCOMMODATION ON THE TRANSITIONAL AERODYNAMIC DRAG OF METEORITES.

R.M.L.Baker, Jr.

Astrophys. J., Vol. 130, No. 3, 1024-6 (Nov., 1959).

A revision of earlier results (Abstr. 6450 of 1959) to take account of the recent suggestion that the accommodation coefficient may not be equal to unity. G.A.Chisnall

523.5

12269 AN OBSERVATION CONCERNING MEAN RADIANT PATHS OF PHOTOGRAPHIC METEOR SHOWERS.

F.W.Wright.

Astron. J., Vol. 65, No. 1, 33-9 (Feb., 1960).

A survey of twelve meteor showers photographed at Harvard indicates that the sun is never more than a few degrees from the extended great circle through the mean daily path of radiant motion for the corresponding shower. When the earth takes some time in passing through the stream, the daily radiant seems to advance along a great circle path towards the position of the sun at the time of maximum shower activity. This observation can be explained if it is assumed that, when the earth encounters individual members of a meteor stream, the heliocentric velocity vectors of these individual members are approximately parallel. The observation can prove to be a convenient tool in the future whenever the data for a meteor shower are few or inaccurate.

523.5

12270 PHOTOGRAPHIC LYRID METEORS.

F.W.Wright, L.G.Jacchia and B.W.Boehm.

Astron. J., Vol. 65, No. 1, 40-5 (Feb., 1960).

This analysis shows that the mean radiant path of the photographic Lyrids has a daily motion of 16' eastward and 10' northward with respect to the equator in the interval from April 7 through April 23 UT. The mean deviation of an extended meteor trail from the mean moving radiant is ±23'. This value is in general agreement with the relation between meteor stream widths and radiant deviations which was derived for eleven other photographic streams. At the time of maximum activity of the Lyrids, on April 22 UT, the sun is only 6° from the extended mean radiant path. This agrees with a recent observation (preceding abstract) that the sun is never more than a few degrees from the extended mean radiant path of a meteor shower near the time of maximum activity.

523.5

12271 COSMIC-RAY-PRODUCED HELIUM IN THE KEEN MOUNTAIN AND CASAS GRANDES METEORITES.

J.H.Hoffman and A.O.Nier.

J. geophys. Res., Vol. 65, No. 3, 1063-8 (March, 1960).

The He^3 and He^4 distributions have been measured in the iron meteorites Keen Mountain and Casas Grandes. In the former, a small meteorite (6.75 kg), the He^3 and He^4 concentrations did not depend upon position. In the latter, a large meteorite (1550 kg), a "depth effect" was observed, and contours of constant He^3 and He^4 content could be drawn. An attempt is made to explain the results in terms of the model earlier presented in connection with similar work on the Grant meteorite.

523.

12272 ISOTOPIC COMPOSITION OF PRIMORDIAL XENON.

J.H.Reynolds.

Phys. Rev. Letters, Vol. 4, No. 7, 351-4 (April 1, 1960).

Summarizes measurements made of the inert-gas isotopic composition of the Richardton, Murray and Pesyanoe meteorites. Several anomalies are indicated and there is clear evidence that the gas composition is in many cases due to a mixture of primordi gas and that produced by nuclear reactions due to cosmic radiation Suggestions are put forward to help in explaining some of the anom ies. R.H.Thom

523

12273 THE DETERMINATION OF RHENIUM AND OSMIUM I IRON METEORITES BY NEUTRON IRRADIATION.

W.Herr, W.Hoffmeister and J.Langhoff.

Z. Naturforsch., Vol. 15a, No. 2, 99-102 (Feb., 1960). In German.

1-2 g of turnings and chips of different iron meteorites were irradiated for 3 days with 10^{12} neutrons per cm^2 per sec, before R and Os were extracted from them. The Os content of 10 meteorite was found to be 5 to 10 times the Re content. The concentrations o Os and Re were of the order of 1-3 p.p.m. and 0.2 p.p.m., respectively. The exception to this was the meteorite Sichote-Alin whose Os and Re concentrations were < 0.025 p.p.m. and $\ll 0.01$ p.p.m., respectively. For the other nine meteorites an average value of 0.071 atoms of Re and 0.64 atoms of Os per 10^6 atoms of Fe was calculated taking into account an average figure of 7% Ni in the meteorites. R.Schnurman

523.5 : 551.

DECAY OF LIGHT FROM A METEOR TRAIN. See Abstr. 122

525 : 551

PROFILE OF UPPER-ATMOSPHERE AIR DENSITY AT THE HEIGHT 180-212 km DERIVED FROM THE ORBIT OF SPUTNIK I See Abstr. 12149

523.

12274 OBSERVATIONS OF COMETS AND OF ICARUS (1566),

H.M.Jeffers and J.Gibson.

Astron. J., Vol. 65, No. 3, 163-5 (April, 1960).

The paper includes 59 measures of the position of comets, and of one minor planet, Icarus (1566), visible during the period April 1958 to October 1959. Descriptions of appearance and estimates of magnitude are also given.

523

12275 OBSERVATIONS OF COMET VÄISÄLÄ, 1939 IV, 1959 i

J.Gibson.

Astron. J., Vol. 65, No. 3, 165 (April, 1960).

The comet was recovered November 11, 1959 at Lick Observat Subsequent observations through March 1960 are presented.

523

12276 CATHODIC SPUTTERING AND COMETARY NUCLEI.

A.Dauvillier.

C.R. Acad. Sci. (Paris), Vol. 250, No. 19, 3080-2 (May 9, 1960). In French.

Near the orbit of Venus the radial "solar wind" has a velocity of ~ 50 km/sec. The interstellar gas clouds (H and He of density $\sim 10^9$ atoms/cm^3) will thus have a velocity relative to a comet's nucleus of $\sim 10^2$ km/sec. This latter value corresponds to kinetic energies of 50 eV and 200 eV for H and He, respectively. Under these conditions, a reaction analagous to the sputtering that occurs at the cathode of a discharge tube will be possible. In the low-pressure interplanetary space, cometary material in the nucleus will be disrupted; each colliding He atom freeing ~ 200 atoms of nuclear matter. Such a mechanism can account for some importan features of cometary observations. D.R.Barbe

523.7

12277 THE PROFILE OF SOLAR HYDROGEN-LYMAN-α.

J.D.Purcell and R.Tousey.

J. geophys. Res., Vol. 65, No.1, 370-2 (Jan., 1960).

Line profiles were measured on 9 successful spectrograms obtained with a rocket-borne photographic spectrograph on July 2, 195 Lyman-α, at 1215.67 A, is a broad emission line with wings on eith side of centre ~ 1 A wide. Total width at half-maximum intensity i o $\sim$ 1 A. No lines of He II, or Deuterium are seen in the Lyman-α g. At the centre of Lyman-α is a depression forming two maxi- separated by $\sim$ 0.4 A; and consisting of a broad, weak, reversal a deep, narrow, central absorption core, width 0.04 to 0.05 A. broad central absorption probably originates in the solar atmos- re; whilst the narrow absorption core is attributed to H between E-layer of the ionosphere and the Sun. Its half-intensity width etween 0.025 to 0.04 A, after correcting for instrumental profile. se values correspond to Doppler temperatures between 800° and 0°K.

D.R.Barber

523.74

12278 SOLAR ACTIVITY DURING 1958.

F.Addey.

Brit. Astron. Assoc., Vol. 70, No. 1, 24-29 (Jan., 1960).

A resume of observations made on 346 days by ten members of B.A.A. Solar Section and covering 13 solar rotations. Naked-eye spots were present on 78 days. It was confirmed that the maxi- m of the present cycle of sunspot activity occurred towards the of 1957.

D.R.Barber

523.74

12279 SOLAR ACTIVITY PREVIOUS TO 1750.

W.Gleissberg.

turwissenschaften, Vol. 47, No. 9, 197 (1960). In German.

Based on Chernosky and Hagan reduced annual mean Wolf num- rs (1700-1748), a table of minimum (r_m), and maximum (R_M) lues is presented, up to the maximum of 1750.3 (marking the com- ncement of the standard series of R_M values, cycle 0). Using this litional data, the evidence for the 80-yr period (Gleissberg, 1958) confirmed over a total of 20 eleven-yr cycles. Waldmeier's rela- nship between height of maximum (R_M), and duration of the ascen- g branch of the 11-yr cycle is shown to hold from 1750 onwards.

D.R.Barber

523.75

12280 THE EQUILIBRIA AND ULTRAVIOLET SPECTRA OF H, He I, AND He II IN THE SOLAR ATMOSPHERE.

G.Athay.

trophys. J., Vol. 131, No. 3, 705-16 (May, 1960).

The ionization equilibrium equations and source functions for the s H, He I, and He II are considered under conditions appropriate the solar chromosphere. The equations are formulated in terms both occupation numbers and b_k parameters, in order to clarify eir relationship to earlier work for H and He I. In the case of the ization equations for H, somewhat more approximate forms are opted from those appearing in earlier works, in order to illustrate re clearly the dominant transitions in the equilibrium. The three s considered here exhibit fundamental differences as well as many milarities in both the ionization equations and the source functions. consideration of the ultraviolet spectra indicates that the central ensities in the Lyman-β lines are influenced mainly by the "local" lue of T_e near the region $\tau = 1$, whereas the central intensities of Lyman-α lines are influenced by the distribution of T_e near = 1. For this reason, observations of the Lyman-β profiles and xes by means of rockets and satellites become a much more luable supplement to Lyman-α observations than had previously en supposed.

523.75

12281 PHYSICAL CONDITIONS IN LIMB FLARES AND ACTIVE PROMINENCES. IV. COMPARISON OF TIVE AND QUIESCENT PROMINENCES.

Zirin and E.Tandberg-Hanssen.

trophys. J., Vol. 131, No. 3, 717-24 (May, 1960).

For Pt III see Abstr. 10535 of 1959. Spectra of active and quiescent ominences appearing simultaneously at the limb of the sun are alysed and discussed. The quiescent prominence shows a spectrum entical with that of the chromosphere at 1500 km, with strong lines of He I, and ionized metals and weak He II. The active prominence ows strong He II and very weak ionized metal lines. The lines in the tive prominence are very much broader. The width of lines in either ominence is shown to depend on their excitation potential. It is oposed, as a result of many observations, that, except for strong es such as those of hydrogen and Ca II, the spectra of prominences l into two sharply defined classes, depending on whether they are ot" or "cool".

523.75

12282 RECURRENT GEOMAGNETIC STORMS AND SOLAR PROMINENCES. B.Bednářová-Nováková.

Geophys. Res., Vol. 65, No. 1, 367-9 (Jan., 1960).

It is pointed out that the different terminologies used in the respective articles are responsible for the discrepant results of the author (1954) and Hansen (1959) on the connection between solar prominences and geomagnetic storms. Hansen examines the relation between storms and quiescent prominences, whilst the author was concerned with a particular type of active filament prominence which exhibits quite a different, though characteristic, correlation with recurrent storms.

D.R.Barber

523.75

12283 FORM AND EXTENSION OF THE MONOCHROMATIC CORONA. M.Waldmeier.

Z. Astrophys., Vol. 50, No. 1, 35-47 (1960). In German.

The present paper deals with the results of more than 12 000 height measurements of the corona from 1939 to 1959. The height of the corona measured in the light of the line 5303 A varies according to the frequency of sunspots, increasing from 0.5' during sunspot minima up to 3.4' during spot maxima. This variation occurs not only in the spot-zone, but also in higher latitudes and even at the pole. The greatest coronal heights are measured over the zones of spots and faculae and amount up to 1.4' during spot minima and up to 4.8' during the maxima. The lowest coronal height is observed over the pole, where it is 0.0' during the minima and 1.9' during the maxima. At the equator the coronal heights change from 0.2' to 4.6', and there the maximum value is reached about two years after a spot maximum. Likewise the ellipticity of the coronal isophotes shows its maximum two years after a sunspot maximum. This is due to the fact that the polar corona disappears after a spot maximum, whereas the maximum extension of the equatorial corona is retained for about two more years. The variations of the monochromatic corona are remarkably more pronounced than those of the K-component of the white corona, with regard to their structure as well as to their extension.

523.75

12284 INTERPRETATION OF THE INTENSITY DECREASE IN THE OUTERMOST SOLAR LIMB.

K.H.Böhm and E.Böhm-Vitense.

Z. Astrophys., Vol. 50, No. 1, 69-72 (1960). In German.

Recent measurements of the solar limb intensity profile by Rogerson (1959), using a balloon-borne telescope, are compared with the intensity distributions computed for a model including the blanketing effect (Böhm, 1954) and for De Jager's model V (1952) without this effect. Because the H^--continuum is formed in local thermodynamic equilibrium (Pagel, 1959), information can be obtained about the kinetic temperatures in the high photosphere by this comparison. It is concluded that the influence of the blanketing effect on the temperature stratification of the upper photosphere is considerable, but not as large as in a model atmosphere, where the lines are formed in local thermodynamic equilibrium.

523.75 : 621.391.812.3

12285 SHORT-WAVE FADEOUTS WITHOUT REPORTED FLARES. H. DeMastus and M.Wood.

J. geophys. Res., Vol. 65, No. 2, 609-11 (Feb., 1960).

Short-wave fadeouts were sought which had no associated Hα flare. To carry out this study, Sacramento Peak flare patrol films were re-examined for those days on which short-wave fadeouts (s.w.f's.) had occurred during patrol times without reported flares. Fifteen such fadeouts were reported during the I.G.Y. period. Upon re-examination of the films, 12 of the s.w.f's, were found to be in close-time association with outstanding Hα events, usually in the nature of pronounced plage brightenings. In 2 other cases, seeing was so poor that no definite statement could be made about possible Hα activity. In only 1 case was there definitely no unusual Hα event in time association with the fadeout. For each of the 15 cases, the flare film for the entire day was re-examined without previous knowledge of the time of the s.w.f. Any periods of outstanding Hα activity were selected and their times noted; only after their independent selection were their times matched to s.w.f. times. Usually there was only 1 such outstanding period of optical activity per day. The times association with s.w.f. was, in general, very close. The results indicate that outstanding Hα activity is essential in time relation with s.w.f. occurrence.

523.75 : 537.59

ON THE COSMIC RAY STORMS DUE TO THE SOLAR CORPUSCULAR STREAMS. See Abstr. 11251

523.75 : 551.5

IONOSPHERIC EFFECTS ASSOCIATED WITH THE SOLAR FLARE OF JULY 10, 1959. See Abstr. 12181

523.77

12286 THERMALLY BROADENED STARK PROFILES OF SOME HIGH BALMER LINES. J.T.Jefferies.
Astrophys. J., Vol. 131, No. 3, 690-4 (May, 1960).

Results are given of some computations of the thermally broadened Stark profiles of the Balmer lines, H12, H16, H18 and H26. The calculations are made for ion densities and kinetic temperatures likely to be of interest in solar prominences and flares. The degree of overlap between H26 and H27 is also computed as a function of ion density and mean random atomic velocity.

523.77

12287 POSSIBLE CYCLIC DOPPLER SHIFTS FROM SPIRALING IONS IN ASTRONOMICAL SPECTRA. J.R.Platt.
Astrophys. J., Vol. 131, No. 3, 744-5 (May, 1960).

A beam of ions moving in a magnetic field will have a non-Maxwellian velocity distribution; the emission from such a source will have bright wings with a weak centre, the extension of the wings depending on the relative ability of ions of differing velocities to pick up "optical" electrons. It is suggested that the bright emissions on either side of strong absorption lines in the solar spectrum may be explained in this way. P.A.Young

523.77 : 551.5

12288 THE INFLUENCE OF TEMPERATURE INHOMOGENEITIES ON THE CENTRAL INTENSITY OF FRAUNHOFER LINES. Y.Cuny.
C.R. Acad. Sci. (Paris), Vol. 250, No. 19, 3117-18 (May 9, 1960).
In French.

The method is outlined and results are given for the central intensities of some of the neutral titanium lines; it is concluded that temperature inhomogeneities are insufficient to explain the experimental results. P.A.Young

523.77 : 551.5

12289 COMMENT ON THE GROWTH CURVES OF FRAUNHOFER LINES WITH PURE ABSORPTION P.ten Bruggencate.
Z. Astrophys., Vol. 50, No. 1, 1-6 (1960). In German.

The curves are investigated using the method of weight functions The general case is treated, line absorption starts at an optical depth $\tau = \tau_0$ for continuous absorption. Formulae are given for the case treated by Pecker and for Unsöld's schematic curve of growth. For limiting cases of very weak and very strong line absorption, Pecker's formulae, Unsöld's schematized formulae and the formulae for exponential absorption are compared.

523.8

12290 TIME DERIVATIVES OF THE COMPONENTS OF PROPER MOTION OF STARS. P.Kustaanheimo.
Astron. J., Vol. 65, No. 1, 46-7 (Feb., 1960).

The rates of change with time in the spherical components of the constant motion of a star are deduced by means of direct projection on the local coordinate base vectors. In many textbooks on spherical astronomy these formulae are given incorrectly.

523.8

12291 PROGRESS ON THE AGK3. W.Dieckvoss.
Astron. J., Vol. 65, No. 4, 171-4 (May, 1960).

A report on the programme of deriving new proper motions for the northern AG stars with particulars on systematic and accidental errors.

523.8

12292 REPORT ON THE AGK3R. F.P.Scott.
Astron. J., Vol. 65, No. 4, 175-6 (May, 1960).

The AGK3R programme was organized to fulfill the reference star requirements of the AGK3. Thirteen transit circles situated in the northern hemisphere are participating in the observations of 21 505 reference stars. This work is now essentially 55% completed.

523.8

12293 THE SYSTEM OF FUNDAMENTAL STARS IN THE SOUTHERN HEMISPHERE. W.Fricke.
Astron. J., Vol. 65, No. 4, 177-80 (May, 1960).

A survey of absolute catalogues for southern stars is given which contributed to the construction of the system of FK3 and FK4. Provisional results for the systematic corrections to FK3 are presented.

523

12294 OBSERVATION ON THE ASTROLABE OF FUNDAMENTAL STARS OF BOTH HEMISPHERES. A.Danjon
Astron. J., Vol. 65, No. 4, 180-5 (May, 1960).

The merits of the O.P.L. impersonal astrolabe as a fundament instrument are discussed. A comparison of the results obtained in both right ascension and declination with the astrolabe O.P.L. 12 in 1957 and 1958 demonstrates the degree of consistency of the observations. The immediate need is for an astrolabe in active service Quito which, with astrolabe stations at Paris, Algiers and Wellingt would form a chain sufficient to link up all the fundamental stars from −70° to +77°.

523.

12295 A METHOD OF CONSTRUCTING A REVISED GENERA CATALOGUE. D.Brouwer.
Astron. J., Vol. 65, No. 4, 186-9 (May, 1960).

This paper presents for discussion an outline of a method of constructing a revised General Catalogue. The main object in view is to ensure that the proper motions in the catalogue are free from the systematic errors in the older positional catalogues, yet retain the weight that they may contribute to the proper motions.

523

12296 THE ASTROMETRIC PROGRAM AT SYDNEY OBSERVATORY. H.Wood.
Astron. J., Vol. 65, No. 4, 189-93 (May, 1960).

A description is given of work on Sydney and Melbourne Astro graphic Catalogues, and on minor planets, double stars, and prepar tion for zone catalogues. Errors of photographic astrometry are discussed and the conclusion reached that the one most urgently in need of reduction is plate error.

523

12297 REPORT ON THE CORDOBA OBSERVATORY PROGRAM. L.Gratton.
Astron. J., Vol. 65, No. 4, 197-8 (May, 1960).

The role of the Cordoba Observatory in the field of astrometr is briefly discussed.

523

12298 THE CAPE PHOTOGRAPHIC AND MERIDIAN PROGRAMS. R.H.Stoy.
Astron. J., Vol. 65, No. 4, 199-203 (May, 1960).

An outline is given of the two positional programmes it is intended to carry out at the Cape Observatory during the next ten yea The first is confined to observations of standard stars while the second seeks to extend the KSZ programme to the south pole. The number of observations that can usefully be made of any individual star is discussed and the desirability of supplementing the visual meridian observations by special photographs is pointed out.

523

12299 ASTROMETRIC PROBLEMS IN THE SOUTHERN HEM SPHERE, DESIDERATA ON PARALLAXES AND PRO MOTIONS. W.J.Luyten.
Astron. J., Vol. 65, No. 4, 203-6 (May, 1960).

Deals mainly with special and smaller astrometric problems rather than with extensive systematic ones. The scope of the souther hemisphere is narrowed to mean only that part of the sky south of, say, declination −15° or −20° since the area between −20° and 0° is generally fairly well observed and taken care of by observatories i the north.

523.

12300 THE LICK PROPER MOTION PROGRAM. S.Vasilevskis.
Astron. J., Vol. 65, No. 4, 207-8 (May, 1960).

The plan of relating the Lick proper motions to those based on meridian circles is briefly outlined. A question is also raised whether positions of stars should be determined at Lick.

523.

12301 A NOTE ON THE COLOR EFFECT ON ASTROMETRIC PLATES. L.Gratton.
Astron. J., Vol. 65, No. 4, 213-14 (May, 1960).

A study is made of the systematic errors in the position of a star caused by the colour of the star.

523.8

12302 AN INVESTIGATION OF THE P.F.K.S.Z.
M.S.Zverev.

tron. J., Vol. 65, No. 4, 223-5 (May, 1960).

The Preliminary General Catalogue of 587 Fundamental Faint
rs north of declination -20^{0} (P.E.K.S.Z.) was compiled at the
lkovo Observatory on the basis of 14 catalogues obtained by 10
servatories of the U.S.S.R., Poland, and Roumania. The proper
tions were derived using the AGK2, CG, and Yale Catalogues.
e graphs show the results of comparing the P.F.K.S.Z. system with
FK3, CG, N30, and Puα1 for the epoch 1930.0.

523.8

12303 A PLAN OF U.S.S.R. PARTICIPATION IN ASTROMETRIC OBSERVATIONS IN THE SOUTHERN HEMIHERE.
A.A.Nemiro and M.S.Zverev.

tron. J., Vol. 65, No. 4, 226-7 (May, 1960).

A plan is outlined for an astronomical expedition to the southern
misphere for the purpose of making absolute and differential
eridian observations of stars, and photographic observations of
rs and galaxies.

523.8

12304 VERY ACCURATE POSITIONS OF SELECTED STARS.
J.H.Oort.

tron. J., Vol. 65, No. 4, 229-31 (May, 1960).

Discussion on the subject of transferring the accuracy of the
ndamental system to a list of stars of particular interest.

523.8

12305 ON THE COMPLETION OF THE CARTE DU CIEL.
W.Luyten.

tron. J., Vol. 65, No. 4, 232 (May, 1960).

523.8

12306 THE LUMINOSITY FUNCTION.
W.Luyten.

tron. J., Vol. 65, No. 4, 232 (May, 1960).

An observing programme with the Palomar Schmidt telescope
proposed which would assist in determining the hump in the
ninosity function.

523.8

12307 REFERENCE STARS IN THE SOUTHERN HEMISPHERE.
A.A.Nemiro.

tron. J., Vol. 65, No. 4, 233 (May, 1960).

Discussion is invited on the subject of whether the list of refer-
ce stars for the southern hemisphere satisfies the rigid demands
the F.K.S.Z.

523.8

12308 THE EXTRAGALACTIC DISTANCE SCALE.
P.W.Hodge.

ture (London), Vol. 186, 622 (May 21, 1960).

Colour magnitude diagrams of clusters in the Small Magellanic
oud differ from those in the Galaxy and both differ from those in
e Large Magellanic Cloud. Hence the use of apparent magnitudes
giant stars an an index of distance must be considered unsafe
til these differences are understood. C.Hazard

523.81

12309 PHOTOGRAPHIC DETERMINATIONS OF THE PARALLAXES OF FIFTY-FIVE STARS WITH THE HAW REFRACTOR.
B.G.Crissman.

stron. J., Vol. 65, No. 2, 106-7 (March, 1960).

In continuation of previous lists from Allegheny Observatory,
e parallaxes of 55 stars are presented.

523.82

12310 THREE-COLOR PHOTOMETRY OF AO CASSIOPEIAE.
R.H.Koch.

stron. J., Vol. 65, No. 3, 127-38 (April, 1960).

Numerous photoelectric observations of AO Cas have established
sudden change in the shape of the light curve and have placed the
riable on the U, B, V system. A constant period of revolution has
en proposed, but short-term departures from this period are
ssible. The variations outside eclipse have been determined for
e new light curves and for several old ones.

523.82

12311 PHOTOELECTRIC PHOTOMETRY OF AS ERIDANI.
R.H.Koch.

Astron. J., Vol. 65, No. 3, 139-47 (April, 1960).

Photoelectric light curves of As Eri have been obtained in yellow and blue light and have been analysed for the orbital elements. Additional observations place the binary on the B, V system. The binary is shown to be probably detached and the hot component to be close to the initial main sequence.

523.82

12312 MECHANISM FOR THE PRODUCTION OF RELATIVISTIC ELECTRONS IN THE ATMOSPHERES OF NON-STATIONARY STARS.
I.M.Gordon.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 853-5 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 608-9 (March, 1960).

The 55-day decay of Type I supernovae luminosity can be explained as due to the slowing down of primary protons by collisions. The protons produce secondary electrons which provide the luminosity by synchrotron radiation. The required mass (10^{30} g) is in agreement with astronomical data. Qualitative features are also discussed. R.S.Pease

523.84

12313 THE ECLIPSING SYSTEM, TZ CORONAE-AUSTRINAE.
F.B.Wood.

Astron. J., Vol. 65, No. 1, 23-32 (Feb., 1960).

New light, eclipse, and orbital elements are computed for the eclipsing system TZ CrA. They are based on two-colour photoelectric observations obtained in 1957-58 at the Mount Stromlo Observatory. A brief discussion is given of the uncertainties involved in computed elements of eclipsing systems, and the limiting values for the present case are considered. A method of estimating the mass ratio from the light curve alone is described and applied to TZ CrA. The fainter component appears to be over-luminous when compared to conventional mass-luminosity considerations. Since this is not uncommon in close double star systems, an attempt is made to explain it on theoretical grounds concerned with the evolution of close binaries. The assumptions differ from those usually made.

523.84

12314 TWENTY VARIABLE STARS IN SAGITTARIUS.
D.Hoffleit.

Astron. J., Vol. 65, No. 2, 100-2 (March, 1960).

Periods have been determined for 20 variable stars in VSF 193 in Sagittarius: one semi-regular, one Algol, 17 typical Mira-type, and one (K0 Sgr) with a period of 312 days whose light curve suggests a U Geminorum star, but which is probably a long-period variable with a faint companion.

523.84

12315 DISCUSSION OF OCCULTATIONS OBSERVED IN 1956 AND 1957.
E.McB.Sadler.

Astron. J., Vol. 65, No. 2, 102-4 (March, 1960).

A summary of the results of the analysis of the occultation observations for 1956 and 1957 is presented here.

523.84

12316 PARALLAX, PROPER MOTION, AND MASS RATIO OF Σ 2398(ADS 11632)
H.Eichhorn and H.L.Alden.

Astron. J., Vol. 65, No. 3, 148-53 (April, 1960).

From the 92 McCormick plates of the double star Σ 2398 (1900: R.A. $18^{h}41^{m}7$, Dec. $+59^{0}29'$) which have accumulated since 1919, parallax and proper motion were newly determined. The McCormick material alone does not permit an accurate determination of the mass ratio. Therefore a series of Yerkes 40-in. plates, taken 1902-1904, and an older series of visual observations by Lamp were reduced to the McCormick system and included in the mass-ratio solution. However, the accuracy of the reduction of one series to another is at present still severly limited by yet unknown systematic effects in the positions of the comparison stars. Thus, a method is suggested and applied of exploiting as much as possible the high intrinsic accuracy of the Yerkes series by using the coordinate differences and proper motions in the solution for the mass ratio. For the relative parallax $+0''.287 \pm 0''005$ is obtained for the relative proper motion of the centre of gravity $\mu_{\alpha}\cos\delta = -1''.3188 \pm 0''.0004$ and $\mu_{\delta} = +1''.8347 \pm 0''.0003$, and for $\mathfrak{M}_2 : \mathfrak{M}_1$, the mass ratio, 0.996 ± 0.074. The residuals in both coordinates suggest systematic perturbations in the motions of both components.

523.84

12317 MEASURES OF 241 DOUBLE STARS. C.E.Worley.

Astron. J., Vol. 65, No. 3, 156 (April, 1960).

1062 measures of 241 double stars, made with the 12 in. refractor of Lick Observatory, are presented.

523.84

12318 CEPHEID VIBRATION. T.C.Roy.

Progr. theor. Phys., Vol. 19, No. 5, 470-4 (May, 1958).

Milne's theory is used to compute the luminosity variation of a star under various conditions.

523.84

12319 THE MASSES OF PULSATING STARS. M.Takeuti.

Sci. Rep. Tohoku Univ. First Ser., Vol. 42, No. 2, 71-6 (Aug., 1958).

By using the period-density relation, the masses of pulsating stars of various types have been computed for two limiting values of the pulsation parameter Q. The results are represented in a mass-luminosity diagram.

523.85

12320 THE ESCAPE OF STARS FROM CLUSTERS. IV. THE RETARDATION OF ESCAPING STARS. I.King.

Astron. J., Vol. 64, No. 8, 351-2 (Oct., 1959).

For Pt III, see Abstr. 3037 of 1959. By a simple application of the concept of time of relaxation, it is shown that encounters by escaping stars increase the effective time of relaxation by the time required for an escaping star to leave the cluster. The effect is negligible for large clusters but decreases the escape rate by a third for the smallest clusters.

523.85

12321 THE ESCAPE OF STARS FROM CLUSTERS. V. THE BASIC ESCAPE RATE. I.King.

Astron. J., Vol. 65, No. 3, 122-6 (April, 1960).

An idealized relaxation problem is solved in which encounters maintain a steady state in a velocity distribution with a high-velocity cutoff. In contrast to treatments previously given, the stars here have encounters with each other rather than with a separate group of stars having a fixed velocity distribution. A time-dependent scale factor must be introduced into the velocities in order to conserve energy. Previous treatments of the problem have allowed the stars under consideration to extract energy from the stars encountered and have therefore not represented a true steady-state condition. The escape rate may be affected by the increase in kinetic energy that results from the evolutionary contraction of the cluster, but it is possible for this energy to be introduced in a way that leaves the present result unaffected. The escape rate derived here is one and a half times that recently found by Spitzer and Härm (1958).

523.85

12322 STUDY OF A DARK CLOUD OF THE GREAT RIFT IN CYGNUS. A.C.Pyne.

Astron. J., Vol. 65, No. 3, 154-5 (April, 1960).

The presence of a dark cloud at 1580 parsecs with an absorption of 6^m0 is indicated by star counts in a region near the Fish and Platter nebula in Cygnus. The star density in this region appears to be essentially the same as that in the vicinity of the sun.

523.85

12323 SOME CHARACTERISTICS OF GALAXIES WHICH BEAR ON THEIR USE AS A FUNDAMENTAL ASTROMETRIC FRAME OF REFERENCE. W.W.Morgan.

Astron. J., Vol. 65, No. 4, 222-3 (May, 1960).

Differences in mean colour of reference stars and highly concentrated galaxies are pointed out; certain astrometric implications are described.

523.85

12324 HII REGIONS WITH OUTWARD DECREASING DENSITY. C.Grubissich.

Z. Astrophys., Vol. 50, No. 1, 21-8 (1960). In German.

A model of a nebula with density decreasing with distance from the exciting star is investigated, and curves obtained showing the variation of density, the degree of ionization and the optical depth in the Lyman continuum as functions of the distance. A comparison is made with a model of constant density and with real nebulae and a criterion is obtained for distinguishing between completely and incompletely formed HII regions. P.A.Young

523.8

12325 A STUDY OF VISUAL BINARIES HAVING PRIMARIES ABOVE THE MAIN SEQUENCE. C.B.Stephenson.

Astron. J., Vol. 65, No. 2, 60-79 (March, 1960).

New MK spectral types determined by the author are presented for both components of more than 100 visual binaries having primaries above the main sequence. MK types are also given for one or more components of 40 other systems, some of which are optical pairs. New photometric observations are given for a number of systems for which previous data needed improvement. This materi is used, with previously available data of the same sort for addition visual binaries having off-main sequence primaries, for a discussion of a number of problems. The following conclusions are reached: (1) between A0 and M2 and up to luminosity class II, visual binaries indicate that only luminosity class II needs an appreciable change in the absolute magnitudes assigned by Miss Roman (1952), or Keenan and Morgan (1951); (2) with few exceptions classification of normal stars by visual comparison of slit spectrograms with standard spectra yields spectral types for which the uncertainty in the associated absolute magnitudes does not vary much with position in the H-R diagram, from the main sequence to luminosity class II; (3) the H-R diagram for the components of visual binaries is consistent with current views of the general trends in stellar evolution; (4) hypothetical parallaxes of the wider visual binaries are not usable for mass estimations because of the influence of selection effects; (5) the space motions of the binaries of the present study are mainly small, and are nearly independent of the spectra types of the stars involved; and (6) the physical nature of the stars occurring in visual binaries is nearly independe of the separation of the components.

523.8

12326 PHOTOELECTRIC LIGHT CURVES OF V839 OPHIUCHI. L.Binnendijk.

Astron. J., Vol. 65, No. 2, 79-83 (March, 1960).

Photoelectric observations are presented of 310 yellow and 311 blue magnitudes of V839 Ophiuchi made during the summers of 1958 and 1959. A new period was derived from these observations. The light in the maximum shows a reflection effect (cos θ term), which has a sign opposite to that expected by theory.

523.8

12327 PHOTOELECTRIC OBSERVATIONS OF β LYRAE. L.Binnendijk.

Astron. J., Vol. 65, No. 2, 84-7 (March, 1960).

In connection with the international observing programme of β Lyrae, photoelectric observations were made during six nights in three or four wavelengths with the 28 inch reflecting telescope at the Flower and Cook Observatory. Additional observations were made with the 15 inch siderostat.

523.

12328 THE LIGHT VARIATION AND ORBITAL ELEMENTS U PEGASI. L.Binnendijk.

Astron. J., Vol. 65, No. 2, 88-96 (March, 1960).

Photoelectric observations are presented of 446 yellow and 441 blue magnitudes of U Pegasi made during seven nights in October and November, 1958. The light curve repeated itself during these two months in both wavelength regions, but showed a definite change when compared with LaFara's photoelectric observations made during the years 1949 and 1950. As a consequence, the coefficient of the sin θ term changed considerably during these nine years. The primary eclipse is an occultation. New orbital element derived are compared with orbital solutions found from older observations

523.

12329 OBSERVATIONS OF ϵ AURIGAE. L W.Fredrick.

Astron. J., Vol. 65, No. 2, 97-100 (March, 1960).

Photoelectric observations made at the Flower and Cook Observatory, using the Pierce photometer and interference filters, are presented.

523.

12330 SEARCH FOR ARTIFICIAL STELLAR SOURCES OF INFRARED RADIATION. F.J.Dyson.

Science, Vol. 131, 1667-8 (June 3, 1960).

If extraterrestrial intelligent beings exist and have reached a high level of technical development, one by-product of their energy metabolism is likely to be the large-scale conversion of starlight to far-infrared radiation. It is proposed that a search for sources infrared radiation should accompany the recently initiated search r interstellar radio communications.

523.87 : 539.12

EMISSION OF NEUTRINO PAIRS BY ELECTRONS IN STARS.

e Abstr. 11141

523.877 : 539.17

12331 POSSIBILITY OF A FISSION CHAIN REACTION IN SUPERNOVA TYPE I. P.Fong.

ys. Rev., Vol. 119, No. 1, 241-2 (July 1, 1960).

The possibility of a fission chain reaction is discussed for the rpose of explaining the discrepancy between the observed light tensity of supernova type I in its decaying stage and the amount of ergy available from the spontaneous fission of Cf^{254}. A convernt fission chain reaction would make the energy output many times rger while at the same time would keep the half-life of the light tensity curve the same as that of the spontaneous fission of Cf^{254}. owever, the necessary conditions for this mechanism to contribute preciably to the energy source do not seem to exist in supernova pe I; other mechanisms are required to explain the discrepancy.

523.877 : 539.17

PYCNONUCLEAR REACTIONS AND NOVA EXPLOSIONS.

ee Abstr. 11396

523.877 : 539.17

NEON AND OXYGEN THERMONUCLEAR REACTIONS.

ee Abstr. 11430

525

12332 SPACE SCIENCE. R.L.F.Boyd.

ature (London), Vol. 186, 749-51 (June 4, 1960).

Report of the first International Space Science Symposium held January 1960 at Nice. A hundred papers were presented and cluded the following topics: Earth's atmosphere; ionosphere; smic radiation and interplanetary gas; tracking and telemetry; lar radiation; Moon and planets. Most of the results were obtained om rockets fired during the International Geophysical Year, but nportant data obtained since, especially from lunar and deep space robes, were also presented.

525

12333 ELECTROSTATIC PROPULSION.

Proc. Inst. Radio Engrs, Vol. 48, No. 4, 477-91 (April, 1960).

The thrust (newtons) developed by a system which accelerates space charge limited flow of ions of specific charge q/m (C/kg) rough a voltage V is given by $F = (2\pi/q)\epsilon_0 V^2 R^2 = (2m/q)^{1/2} V^2 P$. is an aspect ratio of ion beam diameter to acceleration distance $_0$, and P is a diode perveance (amp/volts$^{3/2}$). Lines of electric orce extend from charges in transit across the diode to charged urfaces of the accelerator electrode, on which the thrust is thus urely electrostatic. Alkali metals have favourable characteristics or use as propellants because their ions can be produced for small nergy expenditure near 100 eV per ion by surface contact ioniation, while porous tungsten with pore size less than 1 μ is an fficient and convenient emitting surface. For practical values of rust ($F > 0.01$ lbf $= 2.25 \times 10^{-3}$ newtons) and specific impulse $_{sp} > 2000$ sec) alkali metal thrust devices will operate at a few ilovolts and require $R \gg 1$. But for $R \gtrsim 3$, unipolar ion beams ill reverse their direction of flow within a few χ_0. Mathematical olutions to the neutralization problem for thee case of one-dimenional flow of mixed ion and electron beams are presented ssuming no energy exchanges by collisions or plasma instabilities. hese show a periodic spatial potential distribution of wavelengths .027 χ_0 for cesium, corresponding to time fluctuations of the poential at the plasma oscillation frequency in a frame of reference oving with the ions. Electrons having a Maxwellian distribution of elocity at 1000° K have an average velocity much faster than the ons, and for this case it appears that no time independent solution xists. The injection of electrons from strips spaced 2d apart and laced edgewise in the beam is analysed under the hopeful assumption at there are no potential fluctuations along the direction of ionic otion. Electrons oscillate transversely across this direction in a otential trough having a depth midway between the cathode strips qual to $2V_0 d^2/9\chi_0^2$. The electron current density is $75d/\chi_0$ times reater than the cesium ion current density. It is concluded that umerous closely-spaced electron injectors must be used, and that e total electron circulating current must be orders of magnitude greater than the ion current. Finally, if particles having much smaller specific charge than elemental ions could be copiously produced and accelerated, practically useful thrusts could be gained from pencil beam at $R \cong 1$. The complications of neutralization would then probably be eliminated.

525

12334 PHOTON PROPELLED SPACE VEHICLES. D.C.Hock, F.N.McMillan and A.R.Tanguay.

Proc. Inst. Radio Engrs, Vol. 48, No. 4, 492-6 (April, 1960).

The interplanetary trajectories of vehicles propelled by solar radiation pressure are analysed, and are shown to be logarithmic spirals if thrust direction is constant with respect to the vehicle—sun line. The required thrust may be obtained with a solar sail. Sail size as a function of trip time to Mars is determined for solar thrust, oriented tangent to the trajectory. Solar propulsion is compared with chemical and electrical propulsion. It is shown that a solar-sail-powered space vehicle on a journey from earth to Mars operates with a payload and flight time penalty when compared with a ballistic vehicle. However, the work capacity per unit weight of a solar sail is calculated to be superior to an electrical engine, which in turn is vastly superior to a chemical engine when the work is compared on the basis of equal flight times.

525 : 621.384

12335 COMPARISON OF CHEMICAL AND ELECTRIC PROPULSION SYSTEMS FOR INTERPLANETARY TRAVEL.

C.Saltzer, R.T.Craig and C.W.Fetheroff.

Trans Inst. Radio Engrs, Vol. 48, No. 4, 465-76 (April, 1960).

The basic mission parameters which are required for the evaluation of engine performance for interplanetary flights are defined. The engine parameters are also defined, and the relation between these parameters is formulated. The possibility of achieving much larger payload fractions by the use of electric propulsion systems, as opposed to the use of chemical propulsion systems, is indicated. Methods of calculating impulsive orbit transfers between circular orbits, escape and entry from satellite orbits using low thrust, and optimized powered transfer between heliocentric orbits are given.

525 : 621.398

12336 ELECTRICALLY-CONTROLLED DEMAND-THRUST ROCKETS FOR SATELLITE GUIDANCE. D.D.Ordahl.

Proc. Inst. Radio Engrs, Vol. 48, No. 4, 517-19 (April, 1960).

To accomplish accurate control of satellite orbit and/or attitude with rocket motors requires extremely precise regulation of thrusts, generally in the range between 0 to 1 or 0 to 10 lb. It must be possible to turn these control forces on and off in a few milliseconds repeatedly or intermittently over periods of from several months to perhaps several years. For use in such applications, rocket unit were investigated which employ the combination of storable-liquid propellants and demand-thrust injectors capable of complete remote control. An experimental model of a 0- to 10 lb. thrust engine was successfully demonstrated. Three types of electrically actuated control systems are being investigated. These systems employ direct solenoid control, a magnetic ram hydraulic booster, and a micropump with a hydraulic servomechanism. Guidance signals of 50 μA are used to regulate power to the engine controls.

525 : 621.396.963.325

12337 TRACKING AND DISPLAY OF EARTH SATELLITES. F.F.Slack and A.A.Sandberg.

Proc. Inst. Radio Engrs, Vol. 48, No. 4, 655-63 (April, 1960).

In a new method of displaying the predicted paths and real-time positions of artificial earth satellites, cathode-ray tubes are used with two types of map overlay : orthographic projection and Mercator projection. Functions to match these projections are generated electronically. Auxiliary satellite information is catalogued and made available through "light gun" interrogation of the satellites displayed on the c.r.t. The display and orbit simulator can be used as an integral part of a live tracking system. A mathematical derivation of the subsatellite path on the orthographic projection is given.

525 : 621.391.812.63

12338 THE SATELLITE IONIZATION PHENOMENON. J.D.Kraus, R.C.Higgy and W.R.Crone.

Proc. Inst. Radio Engrs, Vol. 48, No. 4, 672-8 (April, 1960).

A number of observations are presented which show a close correlation between c.w.-reflected h.f. signals and passes of artificial earth satellites. The periodic (nonrandom) occurrence of the signal bursts and the symmetry of some burst sequences are indicative of satellite-related phenomena. The occurrence of a variety of satellite related Doppler effects is described and several satellite ionization mechanisms are also discussed. The possible relation of the satellite phenomenon to prior solar activity is mentioned.

525

12339 ANALYSIS OF THE ORBITS OF THE RUSSIAN SATELLITES. D.G.King-Hele.

Proc. Roy. Soc. A, Vol. 253, 529-38 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (See Abstr, 8520 of 1959). The orbital periods of Sputniks 2 and 3 change in an irregular way thus implying irregularities in drag. These variations are used to investigate the variations in air density. The occurrence of an oscillation with a period of 27 days suggests that at least some of the variation in density is due to solar disturbances. The changes in orbital inclination appear, in principle, to provide a valuable method for determining mean wind speeds near perigee height. The regression of the nodes which can be measured very accurately leads to revised values for the constants in the expression for the gravitational potential of the earth. C.Hazard

525 : 551.5 : 621.391.812.63

12340 FARADAY EFFECT IN THE TRANSMISSIONS FROM FAST SPINNING SATELLITES.

R.S.Roger and J.H.Thomson.

Nature (London), Vol. 186, 622-3 (May 21, 1960).

The interaction of satellite spin and the Faraday rotation effect in the ionosphere in producing polarization fading in linearly polarized signals is discussed for the case when the rotation period is small compared to the Faraday fading period. Records of certain satellite transmissions taken at Jodrell Bank experimental station are at present being analysed to determine ionospheric electron contents. A.Boksenberg

525 : 621.396.946

12341 MEASUREMENTS OF THE LAST FEW PERIODS OF SPUTNIK III BY A RADIO DIRECTION FINDER.

J.L.Wolfe.

Canad. J. Phys., Vol. 38, No. 6, 882 (June, 1960).

The calculated times of crossing the 45th parallel along with the times of nearest approach to Ottawa (45°.21' N, 75°.34' W), and also the calculated mean periods, are tabulated for the last 2 weeks of life. A.Boksenberg

525 : 621-52

12342 PERFORMANCE, CONTROL AND GUIDANCE OF SATELLITE VEHICLES. A.W.Lines.

Proc. Roy. Soc. A, Vol. 253, 500-11 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (see Abstr. 8520 of 1960). A consideration of steps which could be taken to increase the scientific value of satellites. The control of satellite orientation an the realization of orbits specified within narrow limits are discusse It is emphasized that the satellite—rocket system should be considered as a single entity in order to achieve optimum performance, the rocket stages, satellite and their equipments being considered as a single entity. C.Hazard

525 : 551.5

RADIATION MEASUREMENTS TO 658 000 km WITH PIONEER IV. See Abstr. 12189

52

12343 FREQUENCY MEASUREMENT OF STANDARD FREQUENCY TRANSMISSIONS. S.N.Kalra.

Canad. J Phys., Vol. 38, No. 6, 881 (June, 1960).

Measurements were made at Ottawa, Canada, using N.R.C. caesium-beam frequency resonator as reference standard (with an assumed frequency of 9 192 631 770 c/s). A table is given of frequency deviations from nominal, quoted in parts per 10^{10}.

529 : 621.373.4

12344 PRELIMINARY FLIGHT TESTS OF AN ATOMIC CLOC IN PREPARATION OF LONG-RANGE CLOCK SYNCHRONIZATION EXPERIMENTS. F.H.Reder and G.M.R.Winkl

Nature (London), Vol. 186, 592-3 (May 21, 1960).

Time deviation curves for two short flights in unpressarized DC-3 aircraft are given. In the longer flight the maximum time uncertainty was 150 nanosec. A.H.W.Beck

PHYSICS

GENERAL

53

12345 REPORT FROM THE CONFERENCE OF THE SWEDISH NATIONAL COMMITTEE FOR PHYSICS IN 1959.

E.Rudberg and L.Hulthén.

Ark. Fys., Vol. 16, Paper 42, 481-526 (1960).

53

12346 SIR FRANCIS SIMON. P.W.Bridgman.

Science, Vol. 131, 1647-54 (June 3, 1960).

Article based on a memorial lecture delivered at Fifth International Conference on Low Temperature Physics and Chemistry. An appreciation of his life and work.

53 : 536.2

12347 SPHERE AND CIRCLE THEOREMS INVOLVING SURFACE DISCONTINUITIES OF POTENTIAL.

G.Power and H.L.W.Jackson.

Appl. sci. Res. B, Vol. 8, No. 3, 254-8 (1960).

New sphere and circle theorems are presented which allow for discontinuities of potential at the surface of separation and are thus of special importance in heat problems where the "radiation" boundary condition applies. Moreover these theorems permit results to be obtained in particular cases which agree with those deduced from previous theorems.

GRAVITATION . RELATIVITY

530.12

12348 DIFFERENTIAL EQUATIONS IN THE SPINOR SPACE. J.Rzewuski.

Acta phys. Polon., Vol. 18, No. 6, 549-72 (1959).

The paper is a continuation of some previous work concerned with an attempt to describe physical laws in the spinor-space rathe than in the Minkowski space. The bilinear connection of the eight real spinor variables $\mathrm{Re}z_\alpha$, $\mathrm{Re}z_{\dot\alpha}$, $\mathrm{Im}z_\alpha$, $\mathrm{Im}z_{\dot\alpha}$ ($\alpha = 1,2$) with the four real vector variables x_μ ($\mu = 1, \ldots 4$) is studied in some detail. It is shown that the remaining four degrees of freedom correspond to four variables φ_μ ($\mu = 1, \ldots 4$) which have the nature of angles or hyperbolic angles. Equations in the spinor space which are covariant with respect to the direct product of two unimodular groups c . c are expressed in terms of the variables x_μ and φ_μ. Thus a correspondence with the conventional treatment in the x_μ-space is established. A provisional discussion of the equations and their solutions is given.

530.12

12349 GEODESICS IN FRIEDMAN—LOBACHEVSKY SPACE. I.G.Fikhtengol'ts.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1322-3 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 937 (Oct., 1959).

530.12

12350 GRAVITATIONAL RADIATION DAMPING OF NON-GRAVITATIONAL MOTION. A.Peres and N.Rosen.

Ann. Phys. (New York), Vol. 10, No. 1, 94-9 (May, 1960).

A material system acted upon by internal forces much larger than the gravitational field is computed. The result is equal to the rate of radiated energy obtained from the linearized theory.

530.12

12351 THE HYPOTHESIS OF THE GRAVITATIONAL EFFECT OF SPIN. O.Costa de Beauregard.

hiers de Phys., Vol. 13, 209-16 (May, 1959). In French.

Postulates a spin gravitational field which is described by the tisymmetric part of the fundamental tensor of geometry with ine connection. Sciama's fundamental equation for the spin gravita- nal field is recovered. The law of motion of a spinless test particle the field is briefly discussed. T.R.Carson

530.12

12352 GRAVITATIONAL RADIATION. A.Peres.

uovo Cimento, Vol. 15, No. 3, 351-69 (Feb. 1, 1960).

A method is established for solving the Einstein equations for system of freely gravitating pole particles, by successive approxi- ations. It is shown how one can choose the solution that repre- nts purely outgoing waves. It is then found that the fifth-order rrection to the acceleration involves a non-conservative term: ergy is lost, by gravitational radiation, in an amount exactly equal that predicted by the linearized theory. This can also be shown directly computing the loss of mass of the system. The validity the linearized theory is then examined: it is shown that it cannot rrectly describe the field at very large distances from the sources, t nevertheless it gives the right result for the radiated energy.

530.12

12353 THE CLOCK PARADOX. E.Loedel Palumbo.

ev. Univ. Nac. La Plata, Ser Segunda, No. 6, 23-54 (Oct., 1959). Spanish.

In a detailed analysis of the motion of a clock S along a closed ajectory formed by two parallel lines and two semicircles, use is ade of the author's geometrical representation of the Lorentz ansformation in terms of real angles (see also H. Amar, Abstr.47 1956). It is found that the system S cannot be regarded as an in- rtial system on account of variation in the velocity of light and of perration phenomena relative to this system. R.A.Newing

530.12

12354 THE ORIGIN AND PRESENT STATUS OF THE SPECIAL RELATIVITY THEORY. H.Dingle.

i. Progr., Vol. 48, 201-19 (April, 1960).

530.12

12355 INTERNAL MOTIONS OF RELATIVISTIC FLUID MASSES. F.Halbwachs, P.Hillion and J.P.Vigier.

uovo Cimento, Vol. 15, No. 2, 209-32 (Jan. 16, 1960).

On the basis of certain general results established by eyssenhoff (Abstr. 513-16 of 1948), Moller, Bohm and Vigier bstr. 212 of 1958) on the behaviour of relativistic fluid masses closed within time-like tubes, the authors study internal motions rresponding to simple physical assumptions. A general new agrangian and Hamiltonian formalism is introduced in terms of nstein—Kramer variables and relativistic Euler angles and plied to some typical physical cases.

530.12

12356 CONCERNING RYABUSHKO'S WORK, "ON THE EQUATIONS OF MOTION OF ROTATING MASSES IN HE GENERAL THEORY OF RELATIVITY". N.S.Kalitsin.

h. eksper. teor. Fiz., Vol. 36, No. 5, 1567-9 (May, 1959). In ussian. English translation in: Soviet Physics—JETP (New York), ol. 36(9), No. 5, 1112-13 (Nov., 1959).

See Abstr. 5600 of 1958.

530.12

12357 THREE-DIMENSIONAL FORMULATION OF GENERAL RELATIVITY THEORY. A.Peres.

ull. Res. Coun. Israel, Vol. 8F, No. 4, 179-94 (April, 1960).

The basic equations of the general theory are written in a shion that singles out the time coordinate from the three space oordinates. This furnishes a unified approach to a large number topics, such as the Cauchy problem, the Lagrangian and the amiltonian formulations of the theory of gravitation, the asymp- tic behaviour of gravitational radiation fields, time-symmetric ravitational waves, and various gauge conditions.

530.12

12358 A MODEL NON-LINEAR EQUATION WHICH ADMITS A PLANE-WAVE SOLUTION. G.Lochak.

.R.Acad. Sci. (Paris), Vol. 250, No. 12, 2146-8 (March 21, 1960). French.

A plane-wave solution of a non-linear equation, previously proposed (Abstr. 10595 of 1960), is studied, furnishing an example when a non-linear signal could appear as a linear one to a macroscopic observer. J.K.Skwirzynski

530.12

12359 PROBLEM OF RAINICH FOR TWO-COMPONENT SPINORS. O.Bergmann.

J. math. Phys. (New York), Vol. 1, No. 3, 172-7 (May-June, 1960).

Some general relations for two-component spinors in general relativity are derived in an attempt to solve the problem of Rainich for this case. A set of algebraic equations allows one in principle to express the current vector in terms of the energy-momentum tensor, and thus in terms of the Einstein tensor, but the author has not succeeded in solving these equations except in a special frame of reference. Weyl's equations (1929) are expressed in terms of the current vector, its derivatives, and the energy-momentum tensor. In the last section, the determination of the spinor variables themselves is studied.

530.12

12360 FURTHER PROPERTIES OF THE ENERGY-MOMENTUM COMPLEX IN GENERAL RELATIVITY. M.Magnusson.

K. Danske Vidensk. Selsk.mat.-fys. Medd., Vol. 32, No. 6, 22 pp. (1960).

It is shown that the energy-momentum complex T_i^k introduced by Møller into the theory of general relativity is uniquely determined, when taken as a function of the metric tensor and its derivatives of the first and second orders, by two transformation requirements: (1) T_i^k is an affine tensor density (of weight one) so that the total energy and momentum of a closed system are transformed as a vector in linear (affine) transformations, just like the energy and momentum of a free particle; (2) T_4^4 is a scalar density in arbitrary spatial transformations so that the total energy in a volume of space is independent of the system of spatial coordinates used. Further, it is shown that, in empty space, it is possible, in accordance with the principle of equivalence, to introduce coordinates along a geodesic such that the gravitational energy-momentum complex vanishes along the geodesic.

530.12 : 525 : 621.396.96

12361 A DOPPLER-CANCELLATION TECHNIQUE FOR DETERMINING THE ALTITUDE DEPENDENCE OF GRAVITATIONAL RED SHIFT IN AN EARTH SATELLITE. R.S.Badessa, R.L.Kent, J.C.Nowell and C.L.Searle.

Proc. Inst. Radio Engrs, Vol. 48, No. 4, 758-64 (April, 1960).

A cancellation technique permits measurement of the frequency of a source moving relative to an observer without the obscuring effect of first-order Doppler shifts. The application of this method to a gravitational red-shift experiment involving the use of an earth satellite containing a highly stable oscillator is described. The rapidity with which a measurement can be made permits the taking of data at various altitudes in a given elliptical orbit. Tropospheric and ionospheric effects upon the accuracy of results are estimated.

530.12

12362 A COMPARISON OF PLANE WAVE SOLUTIONS IN GENERAL RELATIVITY WITH THOSE IN NON-SYMMETRIC THEORY. H.Takeno.

Progr. theor. Phys., Vol. 20, No. 3, 267-76 (Sept., 1958).

Exact plane wave solutions of the field equations in general relativity and those of the field equations in non-symmetric unified field theory are obtained under similar conditions for the case in which electromagnetic fields are present. Main properties of both solutions are compared with each other. The most important result is that, as far as the solutions dealt with in this paper are concerned, the space-time is closely connected with the electromagnetic field in general relativity, while in non-symmetric unified field theory the structure of the Riemannian space-time is determined quite independently of the electromagnetic field.

530.12

12363 QUANTIZATION OF THE FIELD IN THE LINEAR APPROXIMATION IN THE JORDAN—THIRY THEORY. C.Roche.

C.R. Acad. Sci.(Paris), Vol. 250, No. 19, 3128-30 (May 9, 1960). In French.

530.12

12364 MASS OF A CHARGED PARTICLE IN THE SECOND APPROXIMATION TO EINSTEIN'S FINAL UNIFIED THEORY. C.Venini.
R.C. Accad. Naz. Lincei, Vol. 27, No. 6, 362-7 (Dec., 1959). In Italian.

The Einstein—Infeld method is used to discuss the motion of two interacting particles. The approximation to the relativistic mass includes terms corresponding to the mutual electrostatic and gravitational potential energies of the two particles as well as the velocity-dependent terms. R.A.Newing

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

530.14

12365 NONLINEAR GENERALIZATIONS OF THE WAVE-EQUATIONS OF WAVE MECHANICS. G.Petiau.
Cahiers de Phys., Vol. 113, 5-24 (Jan., 1960). In French.

Compares and discusses the various nonlinear wave-mechanical theories proposed in recent years, and makes some extensions of the author's own work on the subject. P.M.Davidson

530.14

12366 GENERALIZATION OF QUANTUM MECHANICS. T.E.Phipps, Jr.
Phys. Rev., Vol. 118, No. 6, 1653-8 (June 15, 1960).

The possibility of generalizing quantum mechanics in such a way as to retain its predictive results, while comprehending additional solutions, is examined. It is found that this can be done through a perfected formal correspondence with Hamilton—Jacobi mechanics, by which one is led to consider generalizations of the Heisenberg postulate of the form $p_kq_i - q_ip_k = S\delta_{jk}$, where S is the quantum analogue of Hamilton's principal function. The formalism is shown to be equivalent to a simple change in Hamiltonian, with transformed momentum operators satisfying conventional commutation relations, and with an additional relationship involving formal analogues of the classical "initial constants" adjoined. A particular choice of $S (= \hbar/i)$ leads to a theory identical with wave mechanics apart from a constant (unobservable) phase factor on the wave-function. The fact that S may possess other, nonconstant values, demonstrated by a specific example, suggests the ability of the mechanical equations to describe a broader class of physical states than has hitherto been investigated.

STATISTICAL MECHANICS TRANSFER PROCESSES

530.16

12367 GENERAL METHOD OF EXACT SOLUTION OF THE CONCENTRATION-DEPENDENT DIFFUSION EQUATION. J.R.Philip.
Austral, J. Phys., Vol. 13, No. 1, 1-12 (March, 1960).

Only three forms of $D(\theta)$ have previously been known to yield exact solutions of the equation

$$\frac{\partial\theta}{\partial t} = \frac{\partial}{\partial x}\left(D(\theta)\frac{\partial\theta}{\partial x}\right),$$

subject to the conditions $\theta = 0$, $x > 0$, $t = 0$; $\theta = 1$, $x = 0$, $t > 0$. The present paper reports a general method of establishing a very large class of $D(\theta)$ functions which yield exact solutions. A similar method enables exact solutions of the same equation subject to the conditions $\theta = 0$, $x > 0$, and $\theta = 1$, $x < 0$, $t = 0$; $\int_0^1 x d\theta = 0$, $t \geq 0$. In this case also a very large class of $D(\theta)$ functions yield exact solutions. Examples are given for both cases. Many of the exact solutions which are most readily found tend to lead to zero or infinite values of D at one or two points of the θ-range. Means of avoiding this difficulty are devised. Practical use of the method is discussed.

530.16 : 51

12368 THE FUNCTION INVERFC θ. J.R.Philip.
Austral. J. Phys., Vol. 13, No. 1, 13-20 (March, 1960).

The function inverfc θ arises in certain diffusion problems whe concentration is taken as an independent variable. It enters into a general method of exact solution of the concentration-dependent diffusion equation. An account is given of the properties of this function, and of its derivatives and integrals. The function

$$B(\theta) = (2/\pi^{1/2}) \exp\left[-(\text{inverfc } \theta)^2\right]$$

is intimately connected with the first integral of inverfc θ and with i derivatives. Tables of inverfc θ and $B(\theta)$ are given.

530.16 : 536.

12369 IRREVERSIBLE COOPERATIVE PHENOMENA. R.Kikuchi.
Ann. Phys. (New York), Vol. 10, No. 1, 127-51 (May, 1960).

An expression is derived for the probability of occurrence of a certain path (for a short time interval τ) for an adiabatic and an isothermal irreversible changes of state of a Markoffian system. The path probability $G(t;t + \tau)$ is written as a function of the path parameters which specify the change of state. $k \ln G(t;t + \tau)$ is made of three terms (k is the Boltzmann constant). The first is the kinetic probability term, which comes from the mechanical transition probabilities. The second is the path entropy for the system, which is k times the logarithm of the number of equivalent paths which share the same path parameters. The third is the path entropy for the heat bath $S^{(b)}$, which can be written in terms of the energy of the system $E^{(s)}$ at times t and $t + \tau$ as

$$S^{(b)} = -[E^{(s)}(t) + E^{(s)}(t + \tau)]/2T + \text{constant}.$$

The most probable path is determined by maximizing $G(t;t + \tau)$ wit respect to the path parameters, with the quantities of the system at time t fixed. This expression of the path probability is first applied to typical statistical mechanical systems to show that the most probable paths agree with the correct rate equations which can be derived on the basis of intuitive arguments. Thus the proposed expression is consistent with all the known principles of irreversibl thermodynamics, including the detailed balance, Onsager's reciprocal relations, and the minimum rate of entropy production for steady state. This method of path probability is then applied to the isothermal irreversible approach to equilibrium of an order-disorder alloy by using the pair approximation of the cluster-variation method. The rates of change of the long-range and short-range order parameters are calculated. In the limiting case the theory exactly leads to the equilibrium properties of the alloy based on the Bethe approximation. The applications of the method to the ideal Fermi and Bose gases are discussed.

530.1

12370 POINTS OF MULTIPLICITY c OF PLANE BROWNIAN PATHS. A.Dvoretzky, P.Erdös and S.Kakutani.
Bull. Res. Coun. Israel, Vol. 7F, No. 4, 175-80 (Dec., 1958).

It is established that almost all Brownian paths in a plane have points of multiplicity c. Two corollaries arise out of this: (1) for every $0 \leq a < b \leq \infty$, the points of multiplicity c of $L(a,b;\omega)$ are, with probability 1, everywhere dense in $L(a,b;\omega)$; (2) for almost all Brownian paths, the set of points of multiplicity c is everywhere dense in the entire plane.

530.16

12371 EXPRESSION OF THERMODYNAMICAL QUANTITIES I TERMS OF A DISTRIBUTION FUNCTION FOR QUASI-PARTICLES. R.Balian and C.De Dominicis.
C.R. Acad. Sci. (Paris), Vol. 250, No. 20, 3285-7 (May 16, 1960). In French.

The thermodynamical quantities for a system of infinite volume are expressed as functions of a quantity containing all the dependenc on the chemical activity and temperature, which is interpreted as a quasi-particle distribution function. This justifies a hypothesis of Landau for Fermi liquids. The expression for the mean energy giv as a particular case the linked cluster expression for the ground state energy. J.Goldston

530.1

12372 NODAL EXPANSIONS. III. EXACT INTEGRAL EQUATIONS FOR PARTICLE CORRELATION FUNCTIO E.Meeron.
J. math. Phys. (New York), Vol. 1, No. 3, 192-201 (May-June, 1960).

For Pt II, see Abstr. 8600 of 1958. The density expansions of e pair distribution function and potential of average force are nalysed topologically in terms of cutting points and bifocal points. he analysis leads to conversion of the expansions into series with luster integrals involving products of the total correlation functions, r) = g(r) — 1, at finite density, rather than the usual zero-density rsell f-functions. An integral equation for the pair potential of verage force and the pair distribution function is thus obtained. he equation is formally exact and closed in pair space, involving o triplet distributions such as occur in the treatments of Kirkwood nd Yvon—Born—Green. Solution of the equation also yields directly e Ornstein—Zernike direct correlation function. Equations for the ree energy in terms of the direct correlation function are presented, us providing a unified and self-consistent treatment of all thermoynamic properties of a many-body system. The relation of the new quation to the Ornstein—Zernike theory of liquids and to phase tranitions is discussed. The possibility of derivation for condensed nases is briefly noted. A simple approximation, involving only the onvolutory terms in the cluster expansions of correlation functions, proposed.

530.16

12373 ERGODICITY CONDITIONS IN QUANTUM MECHANICS.

G.M.Prosperi and A.Scotti.

math. Phys. (New York), Vol. 1, No. 3, 218-21 (May-June, 1960).

These are investigated in the line of thought of recent papers of occhieri and Loinger (Abstr. 9253 of 1959) and of the authors themelves. More precisely, the averaging $\mathcal{A}$ over all the initial states sed in the paper by Bocchieri and Loinger is here substituted by an veraging $\mathcal{B}$ over the initial states belonging to a given cell; that is say, over all the microscopic states corresponding to a given acroscopic state. Restrictions to be imposed on the Hamiltonian in rder that relation

$$\sum_{\nu=1}^{N} \frac{\mathcal{B}(Mu_{\nu}(t)-s_{\nu}/S)^2}{s_{\nu}^2/S^2} \ll 1$$

e satisfied are then looked for. These restrictions could be obined only in an implicit form.

530.16

12374 NUMERICAL INTEGRATION OF THE TRANSPORT EQUATION WITH NO ANGULAR TRUNCATION.

.S.Wilf.

math. Phys. (New York), Vol. 1, No. 3, 225-30 (May-June, 1960).

For any azimuth-independent scattering law, it is shown that the eutron transport equation with external source is rigorously equialent to a coupled system of Fredholm integral equations. These re derived both for vacuum and periodic boundary conditions. A umerical integration scheme is given for solving these integral quations with no angular truncation error, thereby permitting the olution of the Boltzmann equation numerically, with no error but at in the spatial integration. All cross sections are permitted to e arbitrarily given functions of position, if desired.

530.16 : 536.48

12375 MOMENT OF INERTIA OF SUPERFLUID MANY-FERMION SYSTEMS.

R.M.Rockmore.

hys. Rev., Vol. 118, No. 6, 1645-52 (June 15, 1960).

For previous work, see Abstr. 2131 of 1960. The effects of ossible superfluidity on the cranking moment of a large manyermion system moving under periodic boundary conditions are nvestigated within the framework of the theory of superconductivity ecently formulated by Bogolyubov. The Hamiltonian is initially ubjected to Bogolyubov's general unitary transformation. The ollective excitations of the fermions are then considered in the sual pair approximation; the appropriate cranking terms are linear the boson pair operators. On performing a unitary transformation hich transforms away these linear terms, one obtains an expression or the moment of inertia of the system which includes both the ffects of possible superfluidity and collective excitation. This xpression, by virtue of its being stationary with respect to rbitrary variations in the amplitude associated with the latter nitary transformations, is then utilized as a variational principle or the moment of inertia. For the normal state, the result previously btained by the author, that the moment of inertia has the rigid value, rederived in more compact form. For the superfluid state, one nds that collective excitations effect a marked increase in the uperfluid moment at intermediate coupling strengths although the esulting moment is still quite small compared to the rigid value. contrast to the normal state case, where particle—hole pairs play a major role, this increase is almost entirely due to excitations consisting of particle-pairs or hole-pairs. The precise magnitude of the apparent resonance in the moment produced by the d-wave part of the cranking interaction is dependent to some extent on the features of the particle—particle potential which leads to the superfluid state. Variational expressions for the moment are exhibited for both Yukawa and delta-function shell potentials. These results are identical in charged and neutral Fermi systems. A calculation of the cranking moment at finite temperatures is presented together with an interpretation of it in terms of Bardeen's two-fluid model of superconductivity.

530.16

12376 TRANSPORT COEFFICIENTS FROM DISSIPATION IN A CANONICAL ENSEMBLE.

E.Helfand.

Phys. Rev., Vol. 119, No. 1, 1-9 (July 1, 1960).

Expressions for the transport coefficients are obtained by studying the average changes with time which occur in members of a canonical ensemble when the initial state of one particle is partially specified. One calculates, both hydrodynamically and statistical mechanically, an appropriately weighted average of the spread of the initial knowledge. In this way expressions analogous to the Einstein equation for the self-diffusion of a Brownian particle are obtained; viz., the viscosity is proportional to a mean-square centre of mommentum displacement and the thermal conductivity is related to a mean-square centre of energy displacement. These expressions may be converted into the integral of autocorrelation function formulae derived previously by others.

530.16

12377 THEORY OF THE ROTATIONAL BROWNIAN MOTION OF A FREE RIGID BODY.

L.D.Favro.

Phys. Rev., Vol. 119, No. 1, 53-62 (July 1, 1960).

The orientation of a rigid body is specified by the Cayley—Klein parameters. A system of such bodies subject to small random changes in orientation but not subject to any externally applied torque is then considered in some detail. A diffusion equation is derived with certain linear combinations of the Cayley—Klein parameters as independent variables. This equation is expressed in terms of quantum-mechanical angular momentum operators and a Green's function for the equation is obtained as an expansion in angular momentum eigenfunctions. This expansion can be used to calculate averages of various physical quantities in a nonequilibrium distribution. Illustrative examples of both of these applications are given.

530.16 : 539.2 : 538.27

12378 APPROACH TO EQUILIBRIUM IN QUANTAL SYSTEMS: MAGNETIC RESONANCE.

A.Sher and H.Primakoff.

Phys. Rev., Vol. 119, No. 1, 178-207 (July 1, 1960).

Presents a derivation of the "master" or Boltzmann "gain-loss" equation from the Schrödinger equation, i.e. a derivation of the equation for the evolution in time of the probabilities of finding a physical system in its various states from the equation for the corresponding probability amplitudes. The "master" equation is derived for an, in effect completely self-enclosed, "supersystem" [A + B], consisting of a "system of interest", [A], and a "surroundings", [B], in relatively weak mutual interaction. A discussion is given of the range of validity of the "master" equation for [A + B] and it is shown that the random phase assumption is required for the state vector of [A + B] at the initial time only. The normally microcanonical character of the equilibrium statistical configuration of [A + B] is demonstrated and a treatment is given of exceptional, "extremely quantal-coherent", initial statistical distributions of [A + B] which may evolve away from equilibrium. Derivations are also presented of the "master" equation for [A] and of the "master" equation for an individual particle or quasi-particle [q], within [A]; a discussion of the range of validity of these "master" equations is given and the normally canonical character of the equilibrium statistical configuration of [A] is deduced. General solutions of the "master" equations for [A + B], [A], and [q] are worked out and the relation between the principles of "microscopic reversibility" and "detailed balance" and the nonoscillatory character of the approach to equilibrium are exhibited. A theorem is presented regarding the time variation of the entropy of [A]. As illustrations of the general methods developed two important processes in magnetic resonance — the time variation of the longitudinal magnetization, $\langle\mu\rangle_t$, and the time variation of the transverse magnetization, $\langle\mu'\rangle_t$ — are discussed in some detail. It is shown that the variation of $\langle\mu\rangle_t$ with t and of $\langle\mu'\rangle_t$ with t for a "nonrigid" lattice can be described by means of the "master" equation for an individual spin [q] and several special cases are discussed on the basis of the evaluation of the appropriate transition probabilities; a comparison with the "spin-temperature" procedure is also appended. On the other hand, it is demonstrated that for a "rigid" lattice no description of the variation of $\langle\mu'\rangle_t$ with t can be given on the basis of a "master" equation; in this case, quantal coherence effects neglected in the derivation of the "master" equation from the Schrödinger equation are vital and $\langle\mu'\rangle_t$ must be evaluated by a rigorous calculation of Trace {[appropriate time dependent density matrix]μ'}.

530.16 : 536.48

12379 TRANSPORT OF ENERGY AND MOMENTUM BY PHONONS IN FLUIDS. A.Crowe.

Proc. Phys. Soc., Vol. 75, Pt 5, 789-92 (May, 1960).

By applying a transformation due to Bogolyubov, the Hamiltonian operator of an assemblage of interacting bosons is transformed to the Hamiltonian of an assemblage of phonons. This transformation is applied to those operator-functions of the atomic coordinates and momenta, the statistical expectation of which is equal to the macroscopic flow of momentum and of energy. The resulting expressions have the form of the momentum (or energy) of a phonon multiplied by the number of phonons per unit volume and by the velocity of sound. Thus the application of the phonon concept to the transport properties of liquid helium is shown to be in agreement with the dynamics of an assemblage of helium atoms. R.Eisenschitz

530.16 : 536.48

12380 MANY-BODY PSEUDOPOTENTIAL FOR HARD-SPHERE INTERACTION. R.Abe.

Progr. theor. Phys., Vol. 19, No. 1, 1-16 (Jan., 1958).

A many-body pseudopotential for a hard-sphere system which is mathematically equivalent to the boundary conditions imposed on the wave-functions is obtained as a generalization of Huang and Yang's binary pseudopotential (Abstr. 3008 of 1957) and the lowest order term of the ground-state energy resulting from the triple collision is calculated for the Bose system. Instead of the direct perturbational treatment of the pseudopotential, the use of the ρ_k-representation for the Bose system is proposed and the ground-state energy is calculated in this representation. It is shown that the energy thus calculated is of the form of an expansion in powers of $(\rho a^3)^{1/2}$, where ρ is the average density and a the hard-sphere diameter, which is in agreement with Lee and Yang's conclusion (Abstr. 5079 of 1957) drawn from the binary collision expansion method. A discussion of the roton spectrum of liquid He^4 is given.

530.16 : 536.48

12381 QUANTUM-MECHANICAL MANY-BODY PROBLEM WITH HARD-SPHERE INTERACTION. R.Abe.

Progr. theor. Phys., Vol. 19, No. 6, 699-712 (June, 1958).

See also preceding abstract. A theory of the surface pseudopotential for the hard-sphere potential is developed. It is shown that the formulae known to be exact are obtained by the present method. The excitation energy spectrum of the Bose system is calculated, and is shown to have the nonmonotonic behaviour similar to the roton spectrum in liquid He^4. The dispersion formula for the sound velocity is calculated and compared with that derived by Landau and Khalatonikov (1949).

530.16 : 536.48

12382 QUANTUM MECHANICS OF STRONGLY INTERACTING PARTICLES WITH AN APPLICATION TO LENNARD-JONES POTENTIAL. R.Abe.

Progr. theor. Phys., Vol. 19, No. 6, 713-24 (June, 1958).

See preceding two abstracts. The perturbation-theory procedure is developed for a system of strongly interacting particles, by replacing the singular potential with an equivalent operator. As an application of the method, an expression for the ground-state energy of a Bose system which corresponds to Lenz's formula for the hard-sphere system, is obtained for the Lennard-Jones potential. The cohesive energy of liquid He^4 is calculated and is shown to be about twice as large as that experimentally observed. Some difficulties arising from the negative value of the scattering length are discussed, and it is suggested that the assumption, usually made for a Bose system, that nearly all the particles are in the single-particle state with momentum 0, should be altered for actual liquid He^4.

530.16 : 536.48

12383 QUASI-CHEMICAL EQUILIBRIUM THEORY. II. J.M.Blatt and T.Matsubara.

Progr. theor. Phys., Vol. 20, No. 4, 553-75 (Oct., 1958).

For Pt I, see Abstr. 8637 of 1957. The quasi-chemical equilibrium, or pair correlation, approximation to statistical mechanic is written in terms of second-quantization formalism. This involve an extension of the original theory to include an Ansatz for off-diagonal elements of the density matrix. The formal expressions involve "labelling operators" acting in a purely formal Hilbert spac These labelling operators obey Bose commutation rules for correlations between even numbers of particles (e.g., pair correlation Fermi commutation rules for correlations between odd numbers of particles. The labelling operators provide an algebraic way of formulating the restriction to certain types of "graphs". A method is given for including higher-order correlations into the Ansatz. The main results of the original theory can be derived more rapidl with the new formalism. However, certain correction terms obtained earlier are shown to be in error, necessitating a re-investigation of the nature of the condensation phenomenon. This re-investigation proves to lead to no essential modifications of the previous results. The correlation matrices which enter into the Ansatz need to be related to the Hamiltonian of the system, and to the thermodynamic variables which define its thermodynamic state. A variational formulation is developed for this purpose, but no explicit calculations are carried out in this paper.

530.1

12384 THE THEORY OF NON-EQUILIBRIUM RANDOM PROCESSES. R.L.Stratonovich.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 825-33 (March, 1960). In Russian.

The phenomenological equations of motion are employed to deri under certain assumptions, the stochastic equation. As an illustration thermal noise of a non-linear resistance is considered.

530.16 : 541.1

CLUSTER THEORY OF CONDENSING SYSTEMS.
See Abstr. 12094

GENERAL MECHANICS

531.2

12385 A STUDY OF LARGE STRAINS AND THE EFFECT OF DIFFERENT VALUES OF POISSON'S RATIO.

H.Fessler and B.H.Lewin.

Brit. J. appl. Phys., Vol. 11, No. 7, 273-7 (July, 1960).

The frozen-stress photoelastic technique was used to study the stresses on the inner surfaces of T-junctions of pipes subjected to different internal pressures. The peak stresses were always proportional to the applied pressure. The peak strains at a T-junction of hollow pipes under diametral compression were measured for identical shapes, made of materials of different Poisson's ratios. Within the limits of experimental accuracy, the peak strains were found to be independent of Poisson's ratio.

531.2

12386 A PLANE PROBLEM IN THE THEORY OF ELASTICITY FOR A WEDGE, WITH GIVEN BOUNDARY STRESSES O STRAINS. S.M.Belonosov.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 5, 1042-5 (April 11, 1960). In Russian.

Mukhleshvili's integral solutions are obtained by means of Riemann—Mellin's integral transformations and some of their term are computed and tabulated. J.K.Skwirzynski

531.25

12387 STABILITY OF A CANTILEVER CYLINDRICAL SHELL WITH STRENGTHENED EDGES, UNDER EXTERNAL PRESSURE. V.M.Darevskii and R.I.Kshnyakin.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 6, 1294-7 (April 21, 1960). In Russian.

The differential equations are simplified under carefully stated conditions and the critical pressure is derived in terms of elastic constants and the geometry of the shell. J.K.Skwirzynski

531.25

12388 DERIVATION OF GREEN'S TENSOR FOR THE EQUILIBRIUM PROBLEM OF A SHELL WITH SMALL DOUBLE CURVATURES. B.N.Fradlin and S.M.Shakhnovskii.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 6, 1298-1300 (April 21, 1960). In Russian.

The tensor components are derived for a shell with fixed edges and it is shown that integral and differential formulations of the stability conditions are equivalent. J.K.Skwirzynsk

531.25

12389 ON THE SOLUTION OF A CLASS OF PROBLEMS IN MEMBRANE THEORY OF THIN SHELLS. E.Reissner.
Mech. Phys. Solids, Vol. 7, No. 4, 242-6 (Oct., 1959).

It is shown that membrane stresses in shells of revolution for e class of problems for which the normal stress resultants are of e form f(z) cos θ and the shear stress resultant is of the form z) sin θ admit a particularly simple solution in terms of a stress nction U which has earlier been considered. This fact is illustated by solving the problem of flexure of a cantilever shell, and so the problem of a shell with hydrostatic lateral load. The rmulae for the latter case are specialized to the form which they ssume for an ellipsoidal shell, to enable comparison with an earlier olution of this problem.

531.25

12390 TORSION OF BEAMS WHOSE SECTIONS ARE BOUNDED BY CERTAIN QUARTIC CURVES. W.A.Bassali.
Mech. Phys. Solids, Vol. 7, No. 4, 272-81 (Oct., 1959).

Cauchy integral methods are applied to the torsion of a solid otropic cylinder whose section is bounded by a quartic curve which the inverse of an ellipse with respect to any point on its major or inor axis. The complex torsion function, the torsional rigidity nd the shearing stresses are explicitly determined in the general ase, and particular values are found to agree with those already nown for Booth's lemniscate and the elliptic limacon. The distriution of shearing stress on the boundary is computed in two partiular examples.

531.3

12391 DYNAMIC PLASTIC DEFORMATIONS OF SIMPLY-SUPPORTED SQUARE PLATES.
.D.Cox and L.W.Morland.
Mech. Phys. Solids, Vol. 7, No. 4, 229-41 (Oct., 1959).

In this paper an analysis is given within the framework of thin ate theory of the problem of a simply-supported, square plate subcted to a uniformly-distributed rectangular pressure pulse. All fects due to elastic strain, work-hardening and strain-rate are eglected, although some approximate account of the two latter may e made. To simplify the analysis further, Johansen's yield criterion adopted as an approximation to Tresca's. The most important esults concern the maximum displacement and the total time of otion. Errors in these quantities from approximating Tresca's eld criterion are estimated to be about five per cent.

531.3

12392 ELASTIC-PLASTIC TORSION OF A CIRCUMFERENTIALLY NOTCHED BAR. J.B.Walsh and A.C.Mackenzie.
Mech. Phys. Solids, Vol. 7, No. 4, 247-57 (Oct., 1959).

The elastic-plastic torsion of a cylindrical bar with a circumerential notch is investigated. Theoretical predictions of angle of vist and notch root strain are compared with experimental values.

531.3

12393 THE EFFECT OF END CONDITIONS ON THE DYNAMIC LOADING OF PLASTIC SHELLS. P.G.Hodge, Jr.
Mech. Phys. Solids, Vol. 7, No. 4, 258-63 (Oct., 1959).

A circular cylindrical shell of a rigid plastic material is uniormly loaded by a radial step pressure pulse. Explicit formulas re obtained for the maximum deformation in the shell as a function f the shell geometry and pressure magnitude. It is found that for oderately long shells the deformation is essentially independent f the support conditions at the end of the shell.

531.5

12394 HYPERVELOCITY PRECISION IMPACT INSTRUMENT. W.A.Allen, G.E.Meloy and J.W.Rogers.
ev. sci. Instrum., Vol. 31, No. 7, 726-30 (July, 1960).

Reports the development of a hypervelocity precision impact nstrument. The device consists of a specially designed 0.50-calibre mooth-bore gun with an attached projectile guide to ensure collision f the projectile with its target at a prescribed geometrical orientaion. Hypervelocity is defined roughly as velocity in excess of .15 cm/μsec. Conventional propellants are used. Velocities in xcess of 0.30 cm/μsec are obtained. The instrument is designed o that experiments can be performed in a 0.1 μ vacuum. The rojectile guide and an associated system of baffles eliminate the ikelihood of the propellant gases preceding the projectile to the arget. The instrument has been used to check equation of state nformation on the metal involved in the impact; to investigate the henomenon of crater formation; and to produce hypervelocity fluid low for a unique wind tunnel.

531.56

12395 ON THE APPLICATION OF THE STABILITY THEORY OF DIFFERENTIAL SYSTEMS TO THE STABILITY OF MOTION OF A MISSILE. II.
L.Pottsepp and M.Z.v.Krzywoblocki.
Acta phys. Austriaca, Vol. 13, No. 2-3, 321-8 (1960).

For Pt I, see Abstr. 4977 of 1960.

MECHANICAL MEASUREMENTS

531.71

12396 CALIBRATION OF LINE STANDARDS OF LENGTH AND MEASURING TAPES AT THE NATIONAL BUREAU OF STANDARDS. L.V.Judson.
Nat. Bur. Stand. Monogr. 15, 11 pp. (1960).

The methods are outlined, and the equipment used is described briefly. There is a discussion of some considerations that should be given as to whether or not a standard should be submitted to the Bureau. Instructions are given for submitting items to the Bureau for calibration. Information on the use of steel tapes is appended.

531.74

12397 MICROMETER ADJUSTMENT OF MIRRORS AND PRISMS. N.Bárány.
Periodica Polytech., Elect. Engng, Vol. 4, No. 1, 1-16 (1960).

The paper gives the geometrical conditions to be satisfied by a rotating mirror or prism in an angle-measuring instrument. In particular the optimum point of rotation is determined. Such mirrors or prisms are commonly rotated by a micrometer screw and cam. The shape of the cam for typical cases is derived and the effect of the shape of the cam-follower considered. A typical mechanical design is described in some detail. R.W.Fish

531.75

12398 MEASUREMENT OF THE DENSITY OF LIQUID RUBIDIUM. S.Cohen.
Nuclear Sci. Engng, Vol. 2, No. 4, 530-1 (July, 1957).

531.75 : 533.5 : 539.2 : 537.311

VACUUM MICROBALANCE. See Abstr. 11681

531.78

12399 THE APPLICATION OF THE VIBRATING WIRE MEASURING PRINCIPLE TO THE MEASUREMENT OF EARTH PRESSURE. I.K.Lee.
Austral. J. appl. Sci., Vol. 11, No. 1, 65-79 (March, 1960).

A theoretical analysis of the vibrating wire measuring principle is developed. To a close approximation, the strain sensitivity is inversely proportional to the square of the length of the vibrating wire, and is virtually independent of the cross-sectional area. A comparison of the theoretical and measured sensitivities showed that the latter is less than the theoretical value due to initial curvature in the wire. A field earth pressure cell and a laboratory earth pressure cell have been developed which operate on the vibrating wire measuring principle. The field cell records pressures within a 1 per cent. accuracy, and was designed to operate in the 0 to 150 lb/in^2 pressure range. Laboratory cells, with similar accuracy, were used to measure pressures in pressure range of from 0 to 50 and from 0 to 150 lb/in^2. The development of these cells, and the calibration under fluid pressure is described in the present paper.

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

532.1

12400 AN APPARATUS FOR THE MEASUREMENT OF THE ISOTHERMAL COMPRESSIBILITY OF LIQUIDS. THE COMPRESSIBILITY OF MERCURY, OF CARBON TETRACHLORIDE, AND OF WATER. M.D.Peña and M.L.McGlashan.
Trans Faraday Soc., Vol. 55, Pt 12, 2018-24 (Dec., 1959).

An apparatus suitable for measurements of the isothermal compressibility of liquids at pressures up to 30 atm and at temperatures up to 60°C is described. The apparatus was tested by measuring the compressibilities of mercury and carbon tetrachloride and has been used to measure the compressibility of water from 5 to 60°C. The generally accepted measurements of Smith and Keyes (1934) for water have been shown to be seriously wrong.

532.1

12401 EXPERIMENTAL AND THEORETICAL INVESTIGATIONS ON THE OSCILLATING CYLINDER VISCOMETER FOR NEWTONIAN LIQUIDS.

Ali Abdel Kerim Ibrahim and Abdel Monem I Kabiel.

Brit. J. appl. Phys., Vol. 11, No. 7, 283-7 (July, 1960).

A new and exact theory of the oscillating cylinder viscometer is given for Newtonian liquids. The final solution is not a direct relation between the measured quantity θ/ϕ_0 (θ being the angular displacement of the suspended cylinder and ϕ_0 the displacement of oscillation inexorably imposed on the outer cylinder) and the desired quantity η (η is the coefficient of viscosity), since the Bessel function involves η. To render this direct and applicable to Newtonian liquids a dimensionless parameter is introduced into the final solution. The theoretical relation which is derived subject to the condition that η is proportional to n (n being the frequency) satisfies the experimental curve which is subject to the condition that η is constant, at only one point; hence from the coordinates of this point and the dimensionless parameter chosen, the value of η can be determined. Experiments have been carried out on different concentrations of glycerol. The results obtained confirm the validity of theory and method.

532.5

12402 TREATMENT OF DATA FROM CAPILLARY MEASUREMENTS ON NON-NEWTONIAN LIQUIDS.

U.Lohmander.

Ark. Kemi, Vol. 13, Paper 39, 385-92 (1958).

The viscosity—rate of shear relation is deduced in the case of plastic flow. Apparent viscosities are discussed and a method is presented for the treatment of data obtained from measurements with a viscometer consisting of cylindrical tubes connected by a capillary.

532.5

12403 RESISTANCE TO POTENTIAL FLOW THROUGH A CUBICAL ARRAY OF SPHERES.

R.E.Meredith and C.W.Tobias.

J. appl. Phys., Vol. 31, No. 7, 1270-3 (July, 1960).

Precise conductivity measurements on models sectioned out from a cubic lattice of spheres in a continuous medium, indicate that the effective conductance of such a system deviates from the values predicted by Rayleigh's analytic solution of this potential distribution problem. Deviations become particularly significant when the spheres approach close packing, and when the conductance of spheres is much greater than that of the continuum. By use of a different function for potential, and by consideration of higher terms in the series expression for the potential in the continuous phase, Rayleigh's results are modified, yielding an analytical expression that represents effective conductance satisfactorily in the concentration region approaching close packing.

532.5

12404 [CONTRIBUTION] TO THE PROBLEM OF WALL FRICTION IN A STREAM OF WATER AT SUPERSONIC SPEED.

L.F.Vereshchagin, A.A.Semerchan, M.V.Maslennikov and S.S.Sekoyan.

Zh. tekh. Fiz., Vol. 27, No. 7, 1589-90 (July, 1957). In Russian.

Water is passed through tubes with diameters between 0.47 and 1.27 mm under excess pressures of up to 1700 atm. By this procedure the water obtained speed of up to 600 m/sec. An estimate of the frictional dissipation of energy is made by measuring the temperature of the jet near the outlet. Results are shown in graphs. At the greatest speed the rise in temperature is found to be approximately 65 deg. R.Eisenschitz

532.5

12405 HYDRODYNAMICS OF POLYMER SOLUTIONS. II. HYDRODYNAMIC PROPERTIES OF MACROMOLECULES IN ACTIVE SOLVENTS.

O.B.Ptitsÿn and Yu.E.Éizner.

Zh. tekh. Fiz., Vol. 29, No. 9, 1117-34 (Sept., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 9, 1020-36 (March, 1960).

The Kirkwood—Riseman theory of the hydrodynamic properties of linear macromolecules in solution is generalized to the case of highly active solvents in which a molecule does not obey Gaussian statistics because of volume effects. It is shown that the characteristic viscosity $[\eta]$ and the translational and rotational friction constants F_t and F_r are less sensitive to the volume effects than the dimensions of the chains. As a result ϕ and P in the Flory equation

$$\eta = \phi \frac{(\overline{h^2})^{3/2}}{M} \quad \text{and} \quad F_r = P(\overline{h^2})^{1/2}\,\eta_0$$

fall off in value as the quality of the solvent improves. For ϕ this effect approaches 40% and agrees well with experiment. Values of ϕ are also given for a generalization of Zimm's theory given earlier b one of the authors and coincide almost exactly with those in this paper. For P the effect predicted by theory is exceedingly small. T relation between η and F_r does not depend on the solvent. A bibliography of 46 references is given. For Pt I see Abstr. 8657 of 1960. R.G.C.Arridge

532.5 : 551.5

12406 EFFECT OF DENSITY VARIATION ON FLUID FLOW.

Chia-Shun Yih.

J. geophys. Res., Vol. 64, No. 12, 2219-23 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). The effect of density variation on the flow of an incompressible and inviscid fluid is twofold. On the one hand, the inertia of the fluid changes in direct proportion to the density. On the other hand, the body force acting on a fluid element also changes in direct proportion to the density. Since body force is not the only force acting on the fluid, the inertia effect and the gravity effect of density variation do not cancel each other, and many interesting phenomena occur in the flow of a heterogeneous fluid that do not occur in the flow of a homogeneous field. It is shown that the inertia effect can be simply evaluated for steady flows. If the velocity in the steady flow of a heterogeneous fluid in the absence of gravity is multiplied by the square root of the density the result represents a dynamically possible flow of a homogeneous fluid. At the other extreme, when the gravitational effect dominates the flow, it has been shown both analytically and experimentally that the motion of a fluid is confined to the layer at which it originates. As usual, it is when the inertia effect and the gravity effect are comparable that the solutions of stratified flows become difficult, even if the flow is assumed to be steady and the fluid inviscid. Fro one series of such solutions and the supporting experiments one sees that, on the one hand, infinitely many modes of stationary internal waves of finite amplitude are dynamically possible (apart from the consideration of generation), and, on the other hand, physically significant solutions of stratified flows may involve velocity discontinuities.

532.5

12407 FUNDAMENTAL EQUATIONS FOR THE FLOW OF HOMOGENEOUS FLUIDS THROUGH FISSURED ROCKS.

G.I.Barenblatt and Yu.P.Zheltov.

Dokl. Akad. Nauk SSSR, Vol. 132, No. 3, 545-8 (May 21, 1960). In Russian.

532.5

12408 CORRECTIONS FOR MEAN-VELOCITY AND TURBULENCE MEASUREMENTS FOR HIGH TURBULENCE LEVELS.

Siao Tien-To.

Scientia Sinica, Vol. 8, No. 12, 1558-69 (Dec., 1959).

The influence of the different functional forms of the probability density of the velocity variation on the measurement of mean velocity by hot wire or by mechanical means and on the measurement of turbulence by hot wire is examined. To cover a large range, four probability-density functions are chosen, namely, a normal, a triagular, a rectangular, and a sinusoidal function. For simplification, the fluctuation of velocity only in the direction of the resultant mean velocity is considered. It is found that for high turbulence level the discrepancy between a measurement and the true value depends primarily on the intensity of turbulence and secondarily on the distribution form.

532.5 : 536.2

12409 MEASUREMENT OF LOCAL HEAT TRANSFER COEFFICIENTS WITH SODIUM—POTASSIUM EUTECTI IN TURBULENT FLOW.

K.D.Kuczen and T.R.Bump.

Nuclear Sci. Engng, Vol. 2, No. 2, 181-98 (April, 1957).

Local heat transfer coefficients were measured in a circular, copper tube of inner diameter 0.25 in., outer diameter 0.55 in., and length 36 in. Direct resistance heating of the tube wall from a direc current power source dictated the size and material of the test section. Since the electrical resistivity of copper varies appreciabl ith temperature, the radial heat flux was nonuniform along the ngth. (The temperature drop across the tube wall was small; erefore the heat flux in the radial direction was assumed uniform). he test section was cooled from the inside with the eutectic alloy sodium and potassium (22% Na, 78% K) flowing turbulently in a rtical direction. The range of variables covered in the experiment as as follows: fluid temperature from 85° to 1175° F, fluid velocity to 60 ft/sec, Reynolds number 13 000 to 466 000, Peclet number 8 to 3850, average heat flux 28 600 to 3.2×10^6 Btu/(hr ft^2). The aximum local heat flux was 6×10^6 Btu/(hr ft^2). For the above st conditions the experimentally measured Nusselt numbers nged from 1.4 at the low Peclet number to 22.4 at the high Peclet mber. Most of the fully-developed Nusselt numbers found are wer than indicated by the Lyon—Martinelli equation, but are in ite good agreement with data of most other experimenters. The lues of Nusselt number in the entrance region are about 40% gher than those predicted by Deissler, and approximately 10% gher than the data of Johnson, Hartnett, and Clabaugh. Near a eclet number of 300, the Nusselt numbers observed were lower, a factor of more than two, than the theoretical minimum for lly developed laminar flow. The reason for this abnormality has t been established.

532.5 : 536.2

LAMINAR TUBE FLOW WITH ARBITRARY INTERNAL HEAT URCES AND WALL HEAT TRANSFER. See Abstr. 12518

532.5 : 551.5

THE MOTION OF FLUIDS WITH DENSITY STRATIFICATION. ee Abstr. 12154

532.5 : 551.5

THE NATURAL OCCURRENCE OF TURBULENCE. e Abstr. 12167

532.5 : 61

BLOOD FLOW MEASUREMENTS USING DYNAMICAL ARAMAGNETIC RELAXATION TIMES AND PARAMAGNETIC RACER TECHNIQUES. See Abstr. 12217

532.5

12410 A NEW LONG-PERIOD WAVE RECORDER. W.G.Van Dorn.

geophys. Res., Vol. 65, No. 3, 1007-12 (March, 1960).

The recorder was designed for the study of low-amplitude rface waves of the ocean in the period spectrum intermediate tween the swell and the tides (10 sec $< T < 10^5$ sec). The re- order has a limiting resolution in the pass band of about 0.035 cm water, which is substantially lower than the lowest ambient back- ound found at small island stations in mid-ocean.

532.6

12411 THE DAMPING OF WATER WAVES BY SURFACE FILMS. R.G.Vines.

stral. J. Phys., Vol. 13, No. 1, 43-51 (March, 1960).

Measurements have been made of the stilling of small water pples by surface films of cetyl alcohol. The damping is consider- le and is somewhat in excess of that predicted by existing theories. perfections in the ripples induce a directed surface drift (surface ass transport), and it is possible that this is indirectly responsible r the extra damping. Under natural conditions surface films not ly impede the formation of small waves but they are also very fective in damping them out.

532.6

12412 DISTRIBUTION OF SPRAY FROM IMPINGING LIQUID JETS. K.D.Miller, Jr.

appl. Phys., Vol. 31, No. 6, 1132-3 (June, 1960).

An improvement is made in the treatment of this problem by anz (Abstr. 931 of 1960). The new formulae agree better with periments on the circumferential distribution of flow in the sultant spray. Both treatments use an "ideal fluid" model.

H.N.V.Temperley

LIQUID STATE

(*Liquid helium is included under Low-Temperature Physics*)

532.7

12413 THE RADIAL DISTRIBUTION FUNCTION OF THE ATOMS IN A LIQUID. A.M.Evseev.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 4, 789-92 (April 1, 1960). In Russian.

On the strength of plausible assumptions, the distribution function is derived from a linear, homogeneous integral equation of the type by which Markov processes are specified. The kernel has the significance of the conditional probability distribution of the interatomic separation if the instantaneous value of the separation is given. The author derives the kernel from a simplified model of the liquid in which atoms are represented as rigid spheres and are confined to cells. The function obtained by solving the integral equation has the shape which is characteristic for experimental radial distributions.

R.Eisenschitz

532.7

12414 STRUCTURE OF LIQUID OXYGEN BY NEUTRON DIFFRACTION. D.G.Henshaw.

Phys. Rev., Vol. 119, No. 1, 22-6 (July 1, 1960).

The angular distribution of 1.04 A neutrons scattered by specimens of liquid oxygen at 90.7°, 69.0°. 62.4°, and 54.7°K was measured over the angular range 3° to 78°. Pronounced excess scattering at low angles is taken to be magnetic in origin and its form suggests the possible existence of short-range magnetic order in the liquid. The measured distributions corrected for magnetic scattering were transformed to the radial distribution functions $4\pi r^2[\rho(r)-\rho_0]$. An analysis of these gives 1.2_6 atoms and 1.26 A as the number of neighbours in, and the spacing of the diatomic shell, 2.7 A as the nearest distance of approach of 2 atoms in adjacent molecules in the liquid and about 3.9 A as the spacing of the main density maximum. The total number of atoms in the main density maximum increases from about 16 to 21 atoms for temperature change from 90.7° to 54.7°K. The possible existence of the O_4 molecule is discussed. For similar work on liquid helium see Abstr. 12541-2.

532.7 : 536.2

12415 COMMENTS ON THE PAPER BY A.S.PREDVODITELEV, "THE COEFFICIENTS OF THERMAL CONDUCTIVITY AND VISCOSITY OF LIQUIDS AND COMPRESSED GASES". V.A.Solov'ev.

Zh. tekh. Fiz., Vol. 29, No. 6, 791-5 (June, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 6, 713-16 (Dec., 1959).

Questions Predvoditelev's assumption that the coefficients can be resolved into two terms and shows that his method of calculation of the second term from the continuum model of a liquid in which Debye waves are propagated is physically unsound and contains mathematical errors.

S.Weintroub

532.7 : 539.2

12416 RESULTS OF INVESTIGATIONS AT LOW TEMPERATURES XXVII. COMPARISON OF THE ATOMIC AND MELTING HEATS AND OF THE ENTROPIES OF THE CONDENSED ISOTOPES Ne^{20} AND Ne^{22}.

K.Clusius, P.Flubacher, U.Piesbergen, K.Schleich and A.Sperandio. Z. Naturforsch., Vol. 15a, No. 1, 1-9 (Jan., 1960). In German.

For previous work see Abstr. 1560-2 (1960). From 350 litres of commercial neon the pure isotopes Ne^{20} and Ne^{22} have been produced in litre quantities in a thermal diffusion plant. The following thermodynamic constants were measured: atomic heats in the solid and liquid state, the melting points (24.66° and 24.84°K), heats of melting (79.23 and 79.74 cal/g-atom) the triple point pressures (325.10 and 327.73 mm Hg) and the difference in entropy of 0.272 ± 0.020 cal /degree gram-atom. The latter has to be compared with the statistical value $1.5R\ln(22/20) = 0.284$. Theoretical expressions are given for the temperature dependence of the difference of specific heat and entropy on the basis of the Debye theory.

H.London

532.7

12417 SELF DIFFUSION IN LIQUID In—Sn ALLOYS. M.Vicentini and A.Paoletti.

Nuovo Cimento, Vol. 14, No. 6, 1373-80 (Dec. 16, 1959).

Further self-diffusion experiments in In-1% Sn and Sn-1% In alloys, using In^{114} and Sn^{113} as tracers, confirm the results previously obtained in the In—Pb system. Within the experimental errors the activation energy is independent of the tracer. A "wall effect" already found in pure Indium and in In—Pb alloy affects the In—Sn results too. This effect is discussed and it is shown that it cannot be due to turbulent diffusion.

532.7 : 537.3

12418 HIGH-FIELD CONDUCTION CURRENTS IN LIQUID n-HEXANE UNDER MICROSECOND PULSE CONDITIONS.

P.K.Watson and A.H.Sharbaugh.

J. Electrochem. Soc., Vol. 107, No. 6, 516-21 (June, 1960).

A novel pulse technique has been developed for measuring conduction currents due to millisecond, microsecond, and submicrosecond pulses of voltage. Using this method, a study has been made of conduction currents in liquid n-hexane at fields from 0.1 to 1.4 MV/cm and at gap spacings from 2.5 to 25 mils. No evidence for electron multiplication was obtained at fields below 1.25 MV/cm, but there are marginal indications of the beginning of an α-process above 1.3 MV/cm. At fields near breakdown extremely large values of current have been measured; the authors' calculations indicate that these currents originate at microscopic points on the cathode surface. Because of the large current density and the high local field, the energy input to the liquid at the tips of these asperities is possibly as large as 10^7 W/cm^3. This could lead to local vaporization of the liquid to form a bubble even in times as short as a few microseconds. If a bubble is so formed, then breakdown of the liquid could readily proceed by subsequent growth of the bubble across the gap to form a spark channel.

532.7 : 539.2 : 537.3

12419 A NOTE ON THE VISCOSITY AND RESISTIVITY OF LIQUID GALLIUM.

N.Cusack and P.Kendall.

Proc. Phys. Soc., Vol. 75, Pt 2, 309-11 (Feb., 1960).

A Batchinskii plot of density/viscosity versus density for liquid gallium was shown by Goryaga and Morgunova [Nauchnȳe Dokladȳ Vȳsshei Shkolȳ (Fiziko-Matematicheskie Nauki) Vol. 1, No. 1, 180-3 (1958)] to possess a sharp change of slope at 350°C, but not at the melting-point. These effects may have been due to structure changes or aggregation. Measurements of resistivity and Seebeck coefficient fail to indicate any evidence of such changes. C.A.Hogarth

532.7 : 541.18

12420 ELECTROSTATIC REPULSION BETWEEN DIFFUSE ELECTRIC LAYERS IN BILATERAL LIQUID FILMS.

A.Sheludko and D.Ekserova.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 1, 149-51 (July 1, 1959). In Russian.

The existence and magnitude of this repulsion assumed to explain the effect of electrolytes on the stability of foam stabilized with low-molecular foam-forming agents [see Bartsch, Kolloid Beihefte, Vol. 20, 1 (1924); Deryagin and Titievskaya, Kolloidnȳi Zhurnal., Vol. 15, 416 (1953)] was further investigated by the authors. According to Deryagin and Landau [Zh. eksper. teor. Fiz., Vol. 15, 663 (1945)], the "wedge" pressure in foam films, due to the diffuse electric layers on either side of the film, equals

$$2\pi nkT(\cosh(e/kT)\varphi_\alpha - 1)$$

for a dissociated 1—1 electrolyte, where e is the ionic charge and φ_α the potential in the centre of the foam film: experiments carried out by the authors have confirmed that the theory of electrostatic repulsion between diffuse layers in bilateral double layers exactly describes the observed phenomena of formation of equilibrium films more than 0.05μ thick. F.Lachman

532.7 : 537.2

12421 APPARATUS FOR THE STUDY OF THE DIELECTRIC PROPERTIES OF MACROMOLECULAR SOLUTIONS UNDER FLOW.

H.G.Jerrard, T.A.Fisher and B.A.W.Simmons.

Rev. sci. Instrum., Vol. 31, No. 7, 684-9 (July, 1960).

Some solutions show a change in value of their dielectric constant and specific conductance when subjected to shearing stresses produced by a velocity gradient established within them. A detailed account is given of an apparatus which has been used for studying this effect. The solution to be investigated is placed in the annular space between two concentric cylinders. The gap between the cylinders varies from about 0.5 to 0.9 mm and has an average radius of about 9.8 mm. The outer cylinder can rotate at speeds up to 5000 rev/min and, with aqueous solutions, gradients of the order of 3500 π sec^{-1} can be obtained without turbulence. Higher values are possible. The rotation is controlled by a Velodyne unit, which gives a continuously variable drive, and for any setting, gives a constant speed independent of load changes. Speeds are accurately determined by an electronic tachometer. The outer cylinder is of metal and the inner cylinder is made from an insulating material in which an electrode in the form of a narrow band is inserted. The metal cylinder and the electrode form a concentric cylinder capacitor or cell so that an electrical field can be applied in a direction perpendicular to the stream lines. The impedance of the cell filled with the solution under test can be determined over the frequency range 0.03 to 20 Mc/s, using a Schering bridge and a twin-T bridge for the low and high frequency ranges, respectively. A cooling system, controlled by thermostats, is provided to maintain the liquid at a constant temperature. The method of use of the apparatus is briefly described and the precision with which measurements may be made is fully discussed.

532.7 : 537.2 : 621.317.335

12422 APPLICATION OF RESONANT RETARDING SYSTEMS FOR THE MEASUREMENT OF PERMITTIVITY OF SUBSTANCES AT U.H.F.

K.P.Yatsuk and G.N.Bȳchkova.

Zh. tekh. Fiz., Vol. 30, No. 2, 165-7 (Feb., 1960). In Russian.

In a brief theoretical analysis a formula is derived for ϵ in terms of $\Delta f/f$, when a sample with permittivity ϵ is introduced into a resonator. The experimental set-up consists of a sawtooth generator modulating a klystron oscillator, a wavemeter, the measuring resonator, a detector and a display oscilloscope. Liquid are poured into a glass capillary of 1 mm dia. and placed axially into the resonator, with distilled water as a control. Dimensions of the resonator and operating frequencies are given. Experimental results show good agreement with theory. A.Landma

532.7 : 537.5

12423 INFLUENCE OF ELECTRODE SURFACE CONDITIONS ON THE ELECTRICAL STRENGTH OF LIQUIFIED GASES.

D.W.Swan and T.J.Lewis.

J.Electrochem. Soc., Vol. 107, No. 3, 180-5 (March, 1960).

The strengths of liquified argon, oxygen and nitrogen are of the order of 1mV/cm but are found to depend to a marked degree on the nature of the electrode surfaces. The strength can be changed in a regular manner (sometimes by as much as 50%) by changing both th electrode metal and the degree of surface oxidation. The important discovery is that the anode as well as the cathode has a strong influ ence on the strength. This surprising result has, as yet, no obvious explanation in terms of usual breakdown mechanisms but may be ve significant, not only for theories of breakdown in these liquids but f hydrocarbon liquids as well.

532.7 : 537.5

12424 MOLECULAR STRUCTURE AND THE ELECTRICAL STRENGTH OF LIQUID HYDROCARBONS.

T.J.Lewis.

J. Electrochem. Soc., Vol. 107, No. 3, 185-91 (March, 1960).

It is suggested that electrons moving through hydrocarbon liquids are able to excite molecular vibrations of infrared frequencies, and that this provides an effective energy loss mechanism. The relative magnitudes of this loss may be estimated for a wide range of hydrocarbons and other liquids and can be used in a criterion of breakdown. Thus the electrical strengths of these liquids measured under standard conditions may then be compared with th molecular structures. A good correlation is found.

532.7 : 537.5

12425 A NEW STATISTICAL THEORY FOR THE BREAKDOW OF LIQUID HYDROCARBONS.

B.W.Ward and T.J.Lew

J. Electrochem. Soc., Vol. 107, No. 3, 191-5 (March, 1960).

Hitherto it has been accepted that breakdown under pulse conditions occurs in liquid hydrocarbons with an insignificant statistic time lag. Theories have been developed in which the whole of any time lag measured has been assigned to a formative time, but these theories are not at all satisfactory. The paper shows that (a) that a significant statistical time lag does in fact exist provided the experimental procedure is correctly interpreted and (b) that a proper statistical analysis of the previous pulse measurements together with a statistical theory of breakdown shows that these measurements provide clear evidence for rather than against, a statistical time lag, Experimental results are given to show how the statistical time lag depends on electric stress and on cathode conditions.

532.7 : 535.33

12426 **STUDY OF INFRARED REFLECTION SPECTRUM OF LIQUID C_6H_6.** D.A.Dows and J.L.Hollenberg.
chem. Phys., Vol. 32, No. 5, 1581-2 (May, 1960).

Between 650 and 4000 cm^{-1} benzene shows only one detectable flection band (at 675 ± 1 cm^{-1} with a peak reflectance of 0.14). is corresponds to anomalous dispersion in the region of the tense 671 cm^{-1} absorption band. It is found that the reflection fect modifies the integrated absorption of this band by approximately 20%. D.L.Greenaway

532.7 : 535.33

INFRARED ABSORPTION-BAND PARAMETERS IN LIQUIDS.
e Abstr. 12488

532.7 : 538.27

12427 **THEORY OF QUADRUPOLE RELAXATION OF NUCLEAR SPINS IN LIQUIDS.** K.A.Valiev.
. eksper. teor. Fiz., Vol. 38, No. 4, 1222-32 (April, 1960).
Russian.

Quadrupole relaxation of nuclear spins of diamagnetic atoms in quids is treated theoretically. The calculations are carried out der the assumption that thermal motion of the liquid particles is a ee translational diffusion. This assumption is valid for metal and lt melts and for weakly solvated ions in electrolyte solutions. It found that $T_2^{-1} \sim \eta/T$ (η is the viscosity of the liquid), which is in od agreement with the measurements of T_2^{-1} for the I^{127} nuclear in in aqueous solutions of NaI and KI.

532.7 : 538.27

12428 **MEASUREMENTS OF THE TRANSVERSE PROTON RELAXATION TIME IN AQUEOUS SOLUTIONS OF ARAMAGNETIC SALTS BY THE SPIN-ECHO METHOD.**
.D.Korepanov, R.A.Dautov and V.M.Fadeev.
. eksper. teor. Fiz., Vol. 37, No. 1(7), 308-9 (July, 1959).
Russian. English translation in: Soviet Physics—JETP (New York), l. 37 (10), No. 1, 218 (Jan., 1960).

The measurements were carried out at 12.2 Mc/s in a field of a rmanent magnet on the hydrolysis of iron in nitric acid solution. gradual reduction in T_2 was observed with increasing acidity. Increasing acidity is presumed to decrease the concentration of hydroxyl ns in solution, leading to the dissociation of the hydro-iron complex. is leaves increasing amounts of free iron ions in the solution ich are more effective at causing relaxation. J.M.Baker

MECHANICS OF GASES

533.4

12429 **MERCURY BAROMETERS AND MANOMETERS.** W.G.Brombacher, D.P.Johnson and J.L.Cross.
at. Bur. Stand. Monogr. 8, 59 pp. (1960).

The various designs of mercury barometers and manometers re briefly described, with a more extended discussion of the rious design elements which may affect the achievable accuracy. urces of error in measuring pressures are described in considerable detail, particularly for portable instruments, including ale, temperature, gravity, capillarity, vacuum errors and return s column. Methods of minimizing those errors and of making e corrections, including extensive tables, are presented. andard conditions are defined and the pertinent properties of ercury given. 65 references.

533.6

12430 **HYPERSONIC FLOW AROUND THIN BODIES AT HIGH ANGLES OF ATTACK.** V.V.Sȳchev.
okl. Akad. Nauk SSSR, Vol. 13, No. 4, 776-9 (April 1, 1960).
ussian.

The appropriate gas-dynamic differential equations are established in dimensionless form and some simplification introduced by nitting small terms. R.F.S.Hearmon

533.6

12431 **MONTE CARLO CALCULATION OF MOLECULAR FLOW RATES THROUGH A CYLINDRICAL ELBOW AND PIPES F OTHER SHAPES.** D.H.Davis.
appl. Phys., Vol. 31, No. 7, 1169-76 (July, 1960).

A method is devised for the calculation of molecular flow rates through pipes where the mean free path for intermolecular collisions is large compared to the dimensions of the pipes (e.g. in vacuum systems). Results of the calculation are given for a straight cylindrical pipe, a cylindrical elbow, the annulus between two concentric cylinders, a straight cylindrical pipe with restricted openings, and a straight cylindrical pipe with restricted openings and a plate to block the direct beam between the openings.

533.6

12432 **A STUDY OF THE EFFECT OF A LONGITUDINAL PRESSURE GRADIENT ON THE DEVELOPMENT OF A BOUNDARY LAYER.** L.M.Zýsina-Molozhen.
Zh. tekh. Fiz., Vol. 29, No. 4, 450-61 (April, 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, 401-10 (April, 1959).

The effect of a pressure gradient on the deformation of the velocity profiles in a turbulent boundary layer and in the region of transition from laminar to turbulent flow is studied for a variety of flow conditions. Reported semi-empirical methods of calculation of the coordinates of the beginning of the transition to turbulence are discussed and, an empirical method is given for determining the coordinates of the end of the transition region. A method of determining the extent of the transition region therefore results. The factors affecting the extent of this transition region are discussed. T.C.Toye

533.6 : 534.6

ACOUSTICAL SIGNAL DETECTION IN TURBULENT AIRFLOW.
See Abstr. 12463

533.6 : 536.2

THERMAL BOUNDARY LAYER. See Abstr.12512

GASEOUS STATE

533.7

12433 **ISOTHERMAL EXPANSION OF A CLOUD OF GAS.** V.S.Imshennik.
Dokl. Akad. Nauk. SSSR, Vol. 131, No. 6, 1287-90 (April 21, 1960). In Russian.

A quantity of gas is supposed to absorb radiation and to expand under the influence of the increase of energy. This process can in some approximation be regarded as an isothermal expansion and admits a relatively simple mathematical description. In the present note, a one-dimensional solution of the equations of aerodynamics is applied to the process of expansion. Extensive deductions are made and the results are discussed in detail. R.Eisenschitz

533.7

12434 **ON THE DISTRIBUTION FUNCTION FOR DISSIPATIVE PROCESSES IN A RAREFIED RELATIVISTIC GAS.** S.S.Moiseev.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 553-4 (Aug. 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37 (10), No. 2, 391-2 (Feb., 1960).

This is expanded in terms of suitably weighted orthogonal polynomials and expressed in the proper frame of the gas element. P.Gray

533.7 : 537.52 : 537.533

12435 **THE ELECTRIC STRENGTH OF A HIGH-VOLTAGE MERCURY TUBE.** D.D.Aleksandrov, N.F.Olendzkaya and S.V.Ptitsȳn.
Zh. tekh. Fiz., Vol. 29, No. 5, 669-70 (May, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 596 (Nov., 1959).

Curves for breakdown voltage against electrode separation are given for mercury vapour at pressures of the order of 1 micron. A similarity with sealed-off vacuum tubes is suggested. D.Walsh

VACUUM PHYSICS

533.5

12436 USE OF THE OMEGATRON IN THE DETERMINATION OF PARAMETERS AFFECTING LIMITING PRESSURES IN VACUUM DEVICES. D.Lichtman.
J. appl. Phys., Vol. 31, No. 7, 1213-21 (July, 1960).

The omegatron mass spectrometer was used to determine residual gases in vacuum systems, including ion pump systems. The predominant residual gas in ion pumps was found to be methane, while the gases found in oil diffusion pump systems include water vapour and carbon monoxide. Analysis was performed to determine the residual gases in vacuum tubes which are difficult to outgas, and conditions that lead to considerable hydrogen content are described. Examples of the use of the omegatron mass spectrometer as a tool in aiding solution of outgassing problems are given.

533.5

12437 METAL VACUUM EQUIPMENT. N.Warmoltz and E.Bouwmeester.
Philips tech. Rev., Vol. 21, No. 6, 173-7 (1959-60).

533.5

12438 NEW TYPE OF COLD CATHODE VACUUM GAUGE FOR THE MEASUREMENT OF PRESSURES BELOW 10^{-3} mm Hg. G.Barnes.
Rev. sci. Instrum., Vol. 31, No. 6, 608-11 (June, 1960).

A new type of cold cathode vacuum gauge is described which will operate in the 10^{-3} to 10^{-8} mm Hg range It is indicated that the new gauge will probably operate below 10^{-10} mm Hg without further modification. In this gauge, ions are produced by a field-ion emitter source and detected by means of a phosphor screen and scintillation probe. The scintillation probe technique as applied to other vacuum manometers is discussed, and some curves are given in connection with its use in an ordinary ionization gauge.

533.5

12439 HIGH SENSITIVITY MASS SPECTROMETER LEAK DETECTOR. N.R.Daly.
Rev. sci. Instrum., Vol. 31, No. 7, 720-3 (July, 1960).

A new type of mass spectrometer ion detector is described and some of its applications discussed. A positive ion entering the detector is accelerated on to a thin metal foil where it releases secondary electrons, which are in turn accelerated onto an organic scintillator viewed by a photomultiplier; this measures the total ion beam. Those ions which penetrate the foil sufficiently release secondary electrons from the back of the foil, and these are detected in a similar way. The transmission properties for many light ions has been investigated and it has been found that the foils have high transmission for helium ions and high rejection for "air" ions. The results obtained can be applied to improving the sensitivity of leak detectors, appearance potential measurements, and the analysis of small quantities of deuterium in hydrogen.

533.5

12440 ANALYSIS OF GAS EVOLUTION FROM A TITANIUM HYDRIDE GAS GENERATOR.
L.Levine and D.Lichtman.
Rev. sci. Instrum., Vol. 31, No. 7, 731-3 (July, 1960).

Gas analysis on a metal bakeable high vacuum system is carried out with the aid of an omegatron mass spectrometer to determine the purity of hydrogen evolved from a titanium hydride source. Curves of the ion current versus mass-to-charge ratio are shown for the system, before, during and after bakeout as well as during the running of the generator. The generator, after moderate processing, is found to yield hydrogen gas that is 97% pure. The impurities found are water vapour, methane and ethane. An explanation for the presence of these impurities is offered.

533.5

12441 DETERMINATION OF THE COMPOSITION OF RESIDUAL GASES IN VACUUM OBTAINED BY CONDENSATION PUMPS. E.S.Borovik and S.F.Grishin.
Zh. tekh. Fiz., Vol. 29, No. 9, 1110-16 (Sept., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 9, 1014-19 (March. 1960).

Gives the results of an analysis (using a 'time-of-flight' mass spectrometer which is described) of the residual gases in a system evacuated by diffusion and condensation pumps, at four pressures in the range 3×10^{-5} to 10^{-8} mm Hg. When the condensation pump is filled with liquid hydrogen the main constituent of the residual gas is shown to be H_2, formed as the product of the decomposition of hydr carbons; using liquid He in the condensation pump completely remo the H_2. J.Dutto

533.

12442 AUTOMATIC VACUUM CONTROL IN THE 760 TO 1×10^{-8} TORR RANGE.
L.R.Linner, R.I.George and R.B.McQuistan.
Rev. sci. Instrum., Vol. 31, No. 6, 650 2 (June, 1960).

A control system is described with which it is possible to regulate the pressure in a vacuum system over the range of 1 atm to less than 1×10^{-8} torr within ± 5% of the desired pressure. An electrical signal, arising because of a deviation from the prescribe pressure, is used through a servo system, to pulse sequentially solenoid valves which control pumping speed and leak rate. Subsequent to initial adjustments, operation for extended periods is possible without operator attention.

533.5 : 531.75 : 539.2 : 537.31

VACUUM MICROBALANCE. See Abstr. 11681

533.5 : 537.53

ADJUSTABLE GAS LEAK. See Abstr. 12643

VIBRATIONS · ACOUSTICS

534.

12443 THE WAVE EQUATION IN A MEDIUM IN MOTION. W.L.Miranker.
I.B.M. J. Res. Developm., Vol. 4, No. 1, 36-42 (Jan., 1960).

A model for the transverse vibrations of a tape moving betwee a pair of pulleys is devised using a variational procedure. It is shown by means of energy-type integrals that the energy of that portion of the tape between the pulleys is not conserved but that there is a periodic transfer of energy into and out of the system. The solution for the wave equation is then constructed by a method which makes use of functional equations. The solution is observed to be periodic in time, and a modal decomposition of it is derived. A solution is also derived for the case of forced vibrations at the pulley and a class of forcing vibrations which cause unbounded solutions as time increases is isolated. In an appendix, a boundary layer ef is considered which occurs when the velocity of the tape through the pulleys approaches the sound speed of the tape.

534.1

12444 ON THE CALCULATION OF THE AXISYMMETRIC MODES AND FREQUENCIES OF CONICAL SHELLS.
J.E.Goldberg, J.L.Bogdanoff and L.Marcus.
J. Acoust. Soc. Amer., Vol. 32, No. 6, 738-42 (June, 1960).

A numerical method is presented for determining the axisymmetric modes of vibration and natural frequencies of thin conic shells such as loudspeaker cones. Assuming the applicability of the classical theory of thin shells, the pertinent differential equatio are presented in a form which is well-suited to numerical integration on an electronic digital computer. The method may be used al to determine the impedance of the cone at other than the natural frequencies, and to calculate the mechanical impedance of the assembly comprising the cone and the voice coil. Results are shown, by a numerical example, to compare favourably with a previously available method based upon the use of power series.

534.1

12445 THE VIBRATIONS OF A FERROMAGNETIC MATERIA IN AN ALTERNATING MAGNETIC FIELD. L.G.Ipatov
Zh. tekh. Fiz., Vol. 29, No. 5, 662-7 (May, 1959). In Russian.
English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 5, 590-4 (Nov., 1959).

The vibration of ferromagnetic materials in alternating magne fields was analysed phenomenologically, and expressions were obtained for the dependence of the oscillation frequency, the damp constant and stiffness of the system of hysteresis, eddy currents, field modulation amplitude and the steady magnetic field value. It found experimentally that the vibration frequency depends on the magnetic state of the material. S.A.Ahe

534.2

12446 **HOMOGENEOUS SOLUTIONS IN ELASTIC WAVE PROPAGATION.** J W.Miles.

art. appl. Math., Vol. 18, No. 1, 37-59 (April, 1960).

Busemann's method of conical flows is formulated for two-mensional elastic-wave propagation. The equations of motion are duced to either Laplace's equation in two dimensions or the wave uation in one dimension, and solutions then are obtained with the d of complex variable or characteristics theory, respectively. ecial attention is paid to that class of problems in which the perbolic domains (of the two-dimensional wave equation) are mple wave zones, in consequence of which the solutions may be ntinued into the elliptic domain (of Laplace's equation) without plicitly posing the boundary conditions on the boundary separ-ng the two domains. The method is applied to the diffraction P- and SV-pulses by a perfectly weak half-plane.

534.2 : 537.533

12447 **RADIATION OF VOLUME AND SURFACE COMPRESSION WAVES DURING IMPINGEMENT OF A NON-LATIVISTIC ELECTRON STREAM AT THE SURFACE OF A NSE MEDIUM.** G.A.Askar'yan.

. tekh. Fiz., Vol. 29, No. 2, 267-9 (Feb., 1959). In Russian. glish translation in: Soviet Physics—Technical Physics (New York), l.4, No. 2, 234-5 (Feb., 1959).

Estimates efficiency of transformation of electron kinetic energy o compression wave energy, and obtains 2% in a typical case. trasonic radiation in the frequency range $< 10^8$ c/s may be obtained high intensity by (a) bunching the electron stream and (b) curving impingement surface to provide focussing. It is pointed out that electron multiplier may be used as an ultrasonic impulse radiation nerator, and that the effects discussed may play a part in cloud d bubble chambers. B.Meltzer

534.21

12448 **USE OF RECIPROCITY THEOREM FOR COMPUTATION OF LOW-FREQUENCY RADIATION PATTERNS.**

E.White.

ophysics, Vol. 25, No. 3, 613-24 (June, 1960).

Starting with a simple word statement of the reciprocity which ists between forces and displacements in a general elastic solid, is shown that low-frequency radiation of shear and compressional ves from relatively complex sources can be obtained by solving latively simple problems in static elasticity. Illustrative examples clude radiation from radial and tangential pairs of forces acting on wall of a cylinder, pressure in a finite cylinder, and a pair of dial forces in a hole in a plate. For the last case, measurements a plexiglas plate compare favourably with computations.

534.21

12449 **SCATTERING OF ELASTIC WAVES BY SMALL INHOMOGENEITIES.** J.W.Miles.

ophysics, Vol. 25, No. 3, 642-8 (June, 1960).

Rayleigh scattering theory is extended to determine the pertur-tion on an arbitrarily prescribed elastic wave field produced by all inhomogeneities in an otherwise homogeneous, isotropic dium. The general result is applied to the specific problems of scattering of both plane P- and S-waves. It is found that a change compressibility acts at a distance as a simple source and a change density as a dipole, as in the acoustical problem, while a change in ear modulus contributes both simple-source and quadrapole fields.

534.21 : 535.42

DIFFRACTIONAL LIGHT MODULATOR WITH OPPOSED LTRASONIC RADIATORS. See Abstr. 12494

534.21

12450 **PROPAGATION OF SONIC AND SUBSONIC WAVES IN NATURAL WAVEGUIDES TO GREAT DISTANCES.**

Brekhovskikh.

pekhi fiz. Nauk, Vol. 70, No. 2, 351-60 (Feb., 1960). In Russian.

A review dealing with waveguides in the ocean and in the atmo-here, and with the change in form of sound impulses on propaga-n to great distances. R.F.S.Hearmon

534.21 : 550.3

12451 **THE METHOD OF GENERALIZED REFLECTION AND TRANSMISSION COEFFICIENTS.** T.W.Spencer.

ophysics, Vol. 25, No. 3, 625-41 (June, 1960).

Describes a method for predicting the surface response of a ratified half space to the radiation from a localized source when neither the assumptions of the plane wave theory nor the assumptions of the normal mode theory are valid. The earth model consists of a finite number of perfectly elastic, homogeneous, isotropic layers separated by interfaces which are plane and parallel to one another. The method leads to an infinite series for the Laplace transform of the response function (displacement, velocity, stress, etc.) in a multi-interface system. Each term in the series describes all the energy which traverses a particular generalized ray path between the source and the receiver. The specification of the mode of propagation across each stratum (either as an irrotational wave or as an equivoluminal wave) and of the sequence in which the strata are traversed serve to define a generalized ray path. A prescription is given for constructing the integral representation for the disturbance which has traversed such a path directly from the integral representation for the source radiation. The method therefore obviates the necessity for solving a tedious boundary value problem. The time function associated with each term can be obtained by using Cagniard's method.

534.22 : 539.3

VELOCITIES OF SOUND IN Al, Cu, Pb AND Fe AT HIGH PRESSURES. See Abstr. 11974

534.22

12452 **CONVERGING WAVES IN A PLASTIC MATERIAL.** É.I.Andriankin.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 4, 769-72 (April 1, 1960). In Russian.

Defining the property of plasticity in terms of a linear relation between the principal stresses, the equations of motion in a plastic material are formulated. They are applied to a sphere in which a shock front is generated by a pressure pulse on the outer surface. The progress of the shock front is calculated; results are shown in graphs. R.Eisenschitz

534.22

12453 **STUDIES IN THE THEORY OF SHOCK PROPAGATION IN SOLIDS.** W.Band.

J. geophys. Res., Vol. 65, No. 2, 695-719 (Feb., 1960).

A single-parameter visco-elastic model of a shear-yielding solid is defined for which a permanent-regime solution of the equations of motion exists for any finite compression. The "profile" of the compression as a function of distance is obtained in the form of an integral which can be evaluated when the velocity of propagation is known as a function of final compression. It is assumed that the permanent-regime solution approximates actual shock waves, and that the velocity of the permanent-regime profile equals the shock velocity. Observed shock speeds are used to compute shock profiles in a number of metals. The maximum slope of the profile for any one metal increases with increasing compression. The limiting value of the maximum slope as the volume is extrapolated to zero gives a numerical estimate of the viscosity parameter, and this has been done for Al, Pb, Sn, Zn and Zr. Zener's linear theory (1958) of anelasticity has been generalized to materials with cubic crystal structure. The theory of the propagation and attenuation of plane waves, both longitudinal and transverse, along a principal axis of the crystal is presented. The combined effects of relaxation mechanisms and thermal diffusion are included. The significance of the results for the theory of shock propagation are discussed and several questions are raised for later discussion. The general equations for propagation of steady-state compression profiles in shear-yielding, heat-conducting, anelastic solids are given. Methods of solution by successive approximation are developed for Hookean solids, with both adiabatic and isothermal (very steep) profiles, and for non-Hookean solids with shock profiles. The experimental results are corrected to include the effects of thermal conductivity and anelasticity. Heating after-effects of shocks are discussed, including the effects of irreversible heating due to viscous yielding, etc., and it is shown how the temperature of the solid after passage of a shock profile may be calculated.

534.22

12454 **SHOCK WAVES IN REAL GASES.** Yu.P.Lun'kin.

Zh. tekh. Fiz , Vol. 29, No 2, 272-3 (Feb , 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 2, 238-9 (Feb., 1959).

A parameter of the shock wave is related to the pressure, density and enthalpy of the gas behind the front. It is suggested that the calculation of the variable specific heat of an ideal gas which dissociates and ionizes (Abstr. 5449 of 1959; 8740 of 1960) is analogous to the calculation of the properties of a real gas. E.R Wooding

534.22 : 536.55

12455 SPECTROSCOPIC TEMPERATURE MEASUREMENTS IN A SHOCK TUBE USING CN AS A THERMOMETRIC MOLECULE. W.H.Parkinson and R.W.Nicholls.
Canad. J. Phys., Vol. 38, No. 6, 715-19 (June, 1960).

Rotational intensity measurements on the CN spectrum, excited through shock excitation of a powdered mixture of NH_4Cl, KNO_2, and C by helium-driven shock waves in argon have been used to infer "rotational temperatures" of the gas between 6350° K and 8750° K. The measured values agree well with gas kinetic temperatures inferred from simple gas dynamic theory and shock-wave velocity measurements.

534.22 : 541.12

INTERACTION OF WEAK SHOCK WAVES WITH A FLAME FRONT. See Abstr.12105

534.22 : 533.6

12456 WAVE REFRACTION AT AN INTERFACE. C.M.Ablow.
Quant. appl. Math., Vol. 18, No. 1, 15-29 (April, 1960).

A plane wave in one of two perfect gases moves toward the parallel plane interface between the gases. The wave is either continuous or headed by a shock front weak enough that entropy changes may be neglected. Using Riemann's solution of the appropriate hyperbolic partial differential equation, four equations are derived giving the details of the reflected and refracted wave motions. The equations are of first order integro-differential or implicit functional form depending on the boundary conditions and must be solved simultaneously for four functions of a single independent variable. The equations are suitable for numerical step-by-step solution.

534.22 : 537.56

12457 ULTRA-HIGH-SPEED PHOTOGRAPHS REFUTING "COHESION IN PLASMA".
W.C.Davis and A.W.Campbell.
J. appl. Phys., Vol. 31, No. 7, 1225-7 (July, 1960).

In a recent issue of this journal (Abstr. 8245 of 1959) and in a recent book [The Science of High Explosives, M.A.Cook, New York; Rheinhold Publishing Corporation (1958), 1st ed., pp. 158, 420-26], a sequence of framing camera pictures was presented, and the sequence was interpreted as evidence that, as the result of the detonation of a quantity of explosive, a plasma was ejected into the atmosphere, and that the plasma exhibited a strong cohesive force. This paper presents pictures of an essentially identical subject, taken at three exposure times: the same exposure time used for the sequence in the references (4 μsec); 1/20th of that time; and 1/400th of that time. These pictures show that the phenomena are those of a shock wave, and that no new assumption of cohesive force is necessary to interpret the pictures. A simple analysis of the shock wave interpretation using the usual theory is presented to show that the interpretation is consistent with the known properties of air and the explosive used.

534.23

12458 ACOUSTIC TRANSMITTERS AND RECEIVERS, PARTICULARLY FOR LIQUIDS. I. H.H.Rust.
Arch. tech. Messen, No. 289 (Ref. Z 67-1) 39-42 (Feb., 1960). In German.

Discusses various types of radiators: - 1) acoustic radiators; 2) resonant radiators, e.g. a longitudinally vibrating rod with a piston attached to one end; 3) aperiodic radiators; 4) directional radiators. In 1) idealized arrangements are considered: - a) zero order (symmetrically pulsating sphere); b) first order (bipolar pulsating sphere); c) second to n-th order (e.g. "son raugue" in many "piston" dynamic loud speakers in which the "piston" is deformed like a diaphragm when vibrating). Methods are given for increasing radiation resistance of a transducer, "Tonpilz" ("mushroom" or piston type radiator for use in water). Window type magnetostriction radiators are described and reference is made to Stenzel's theoretical work on beam characteristics. Brief references are made to "sound-optics" and to the use of longitudinal radiators in the form of spherical mirrors. A.B.Wood

534.23

12459 MUTUAL ACOUSTIC IMPEDANCE BETWEEN RADIATORS IN AN INFINITE RIGID PLANE.
R.L.Pritchard.
J. Acoust. Soc. Amer., Vol. 32, No. 6, 730-7 (June, 1960).

A series solution has been obtained for the mutual acoustic impedance between two identical circular disks vibrating in an infinite plane. Under simplifying conditions, the resistive and reactive components of the mutual impedance each can be expressed in terms of a simple trigonometric function. The problem was formulated in terms of Bouwkamp's method of integrating over real and complex angles the square of the directional characteristic (relative sound pressure at a large fixed distance) to yield the total radiation impedance. Integrals involved here are similar to a type previously evaluated by Stenzel (1930) and may be expressed in terms of a double series containing Bessel functions of integral and half-integral order. Numerical values of the mutual acoustic impedance obtained by this method for two rigid disks are in good agreement with values obtained by Klapman (1940) by direct integration of the pressure at the surfaces of the disks. The acoustic self impedance and mutual impedance may also be calculated by the same methods for a more general type of circular disk having a prescribe radially symmetric velocity distribution. To illustrate the applicability of these results, the total acoustic loading upon an array of circular disks is calculated by taking into account the mutual acoustic impedance between the disks comprising the array. Numer cal results are given for a circular array of seven identical disks having a radius small relative to a wavelength and vibrating uniform in a common, rigid plane.

534.23 : 621.372.412

12460 RESPONSE OF A LOADED IDEALIZED PIEZOELECTRIC PLATE TO AN ELECTRIC SIGNAL. L.Levi
J. appl. Phys., Vol. 31, No. 7, 1237-42 (July, 1960).

The response of piezoelectric plates and rods are generally treated in the form of "equivalent" electric circuits. When the actual mechanical displacements and strains are of interest, such equivalent circuit treatment may be inconvenient. In the present paper the response of a loaded piezoelectric plate to an arbitrary electric input signal is derived on the basis of certain idealizations which are closely approximated by practical systems.

534.23 : 539.2 : 537.311

ABSORPTION OF SOUND BY SEMICONDUCTOR CURRENT CARRIERS IN A MAGNETIC FIELD. See Abstr. 11667

534.26

12461 SOUND DIFFRACTION AT PERIODICALLY UNEVEN AN INHOMOGENEOUS SURFACES. I.A.Urusovskii.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 4, 801-4 (April 1, 1960).
In Russian.

A theoretical treatment of the subject based on a Fourier transform method is given, and the spectrum of the diffracted waves is derived. R.F.S.Hearmon

534.26

12462 PHOTOGRAPHIC VERIFICATION OF ULTRASONIC PLANE WAVE SCATTERING BY CYLINDERS.
H.D.Nine and N.W.Schubring.
J. appl. Phys., Vol. 31, No. 7, 1274-8 (July, 1960).

The ability to photograph the ultrasonic field around a model may obviate the need for extensive mathematical analysis of ultrasonic or analogous field problems. In this paper a method of photographing an instantaneous field invariant in one direction is describ Through use of a parallel-beamed light pulse of very short duration photographs were made of the ultrasonic field of continuous 3 Mc/s travelling sound waves in water impinging perpendicularly upon the side of a cylindrical tube. Shadowgraphs thus obtained verified the wave shapes predicted by IBM 704 computation of the mathematical analysis.

534.26 : 538.5

SOMMERFELD INTEGRAL AND THE SOLUTION OF DIFFRACTION PROBLEMS FOR WEDGE-SHAPED REGIONS. See Abstr. 12696

534.6 : 533.

12463 ACOUSTICAL SIGNAL DETECTION IN TURBULENT AIRFLOW. M.W.Smith and R.F.Lambert.
J. Acoust. Soc. Amer., Vol. 32, No. 7, 858-66 (July, 1960).

Improvement in detected signal-to-noise ratio is obtained for a periodic signal masked by additive noise and turbulent noise backgrounds. Comparisons are made between autocorrelation, cross-correlation, and a combination of frequency filtering and cross-correlation. Although the latter method provided the greatest improvement, the crosscorrelation technique was the most successful single method. It turned out that the maximum improvement obtainable was limited by the dynamic range of the correlator computer and not by errors due to finite averaging time and scanning the delay. The improvement for signals masked by turbulent noise was found to be about 5 dB less than that obtained for additive noise

534.81

12464 MUSICAL INSTRUMENT TUNING AND TONE SYSTEMS.
EXAMPLES: PIANO, GRAND PIANO, ACCORDION,
RMONIUM, BOWED-STRING INSTRUMENTS. H.Meinel.
stica, Vol. 7, No. 3, 185-90 (1957). In German.
The use of differently tempered scales for pianos and accordions
armoniums must be accepted. In the latter, the octave is
ded into 12 semitones of value $2^{1/12}$, but in the former, octaves
nts wider are used, making the semitone $2.0017^{1/12}$ so that the
s are almost pure untempered. As bowed-string instruments
have pure fifths, they and the piano have similar tuning curves.
causes and results of this agreement are discussed, as well as
technical possibilities.

OPTICS . PHOTOMETRY

535.1 : 539.11

2465 THE PROPAGATION OF LIGHT AND MATTER WAVES
IN LORENTZ SYSTEMS AND ITS GEOMETRICAL
ERPRETATION. G.Rehmann.
ik, Vol. 17, No. 2, 98-106 (Feb., 1960). In German.
The geometrical relationships with reference to the propagation
ight waves in moving systems of reference are investigated and
eometrical interpretation of the Lorentz contraction is found. It
hown that a geometrically evident interpretation of the Schrödinger
ation can be given and the bearing which this may have on a
ry of elementary particles is pointed out.

535.22

12466 VELOCITY OF LIGHT IN A MAGNETIC FIELD.
R.V.Jones.
ure (London), Vol. 186, 706 (May 28, 1960).
A sensitive optical lever with photoelectric detection was used
seek small changes in c due to a transverse magnetic field. No
nificant effect was found in a wedge field of 8000 Oe and it was
cluded that c is not affected more than 2 parts in 10^{13} by such a
d. W.T.Welford

535.22 : 538.3

12467 A PROPOSED EXPERIMENT FOR THE INVESTI-
GATION OF AN ENERGY DEPENDENCE OF PHOTON
LOCITY IN VACUO. S.D.Softky and R.K.Squire.
geophys Res., Vol. 65, No. 2, 619-21 (Feb., 1960).
It is argued that space may be a dispersive medium for electro-
gnetic radiation. Present experimental evidence is inconclusive.
possibility now exists for the measurement of photon velocities
energies ranging from radio frequencies to MeV gamma rays.
radiation source woul be a nuclear bomb and the base line
roximately 2 light seconds. The signal strengths are more than
quate.

535.24

12468 THE DETECTION OF TIME-CORRELATED PHOTONS
BY A COINCIDENCE COUNTER.
.Twiss and A.G.Little.
stral. J. Phys., Vol. 12, No. 1, 77-93 (March, 1959).
The existence of a correlation between the arrival times of
tons has been confirmed by measurements with a coincidence
nter having a resolving time of 3.5×10^{-9} sec in three different
eriments. In the first experiment it was found that the number
coincidence counts recorded from two photomultipliers, the
rtures of which optically superimposed, was significantly greater
n when the light beams were incoherent. Furthermore, the number
hese correlated counts was in satisfactory agreement with that
dicted by theory. In the second experiment the change in the
nber of excess coincidences was measured as the degree of co-
ence of the light was altered by increasing the apparent separa-
of the photocathodes, and in this case also there was reasonable
eement between theory and experiment. In the final experiment
as shown that there was a significant difference between the
nber of coincidences observed when the light beams were in iden-
l as opposed to orthogonal polarizations, and this last result
ecially makes it extremely improbable that the correlation could
caused by some spurious effect, such as plasma oscillations in
source, since the light source itself was found to be completely
olarized.

GEOMETRICAL AND INSTRUMENTAL OPTICS
SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

535.3

12469 AN INVESTIGATION OF DIFFUSE REFLECTION FROM DIFFUSELY ILLUMINATED POWDERS. A.S.Toporets.
Optika i Spektrosk., Vol. 7, No. 6, 803-7 (Dec., 1959). In Russian.

A special spectrophotometer was constructed for investigating diffuse reflection from diffusely illuminated powders and their mixtures. Diffuse illumination was achieved by placing the samples at the centre of a barium-sulphate-coated sphere of 20 cm diameter, into which light was admitted through an opal glass window. The spectrophotometer was used to study diffuse reflection by white (magnesium oxide) and coloured (ultramarine) pigment powders and their mixtures. A.Tybulewicz

535.31

12470 THE DESIGN OF PHOTOGRAPHIC OBJECTIVES OF THE TRIPLET FAMILY. II. THE INITIAL DESIGN OF COMPOUND TRIPLET SYSTEMS. F.D.Cruickshank.
Austral. J. Phys., Vol. 13, No. 1, 27-42 (March, 1960).

For Pt I see Abstr. 4845 of 1958. The general method developed for the type III triplet is extended to the initial design of triplet systems having compound components. The possibility of replacing a single lens by an equivalent doublet or triplet allows the single lens to be regarded as not being restricted to values of N and V associated with known glass types. It follows that the glass parameters α, β, γ, and ξ may be treated as continuously variable over limited ranges. The general effects of the variation of these parameters on the powers and separations of the basic initial solutions are shown in a set of diagrams. As an example, the initial design of a triplet with compound members is given in detail.

535.32

12471 PRECISION PHASE CONTRAST REFRACTOMETRY AND ITS APPLICATION TO HEAVY—LIGHT WATER.
E.Djurle.
Ark. Fys., Vol. 17, Paper 1, 1-59 (1960).

The imaging of objects in the phase contrast refractometer has been treated by means of diffraction theory and the results obtained have been used in the design and construction of a new refractometer. The properties of the instrument have been examined from different aspects, e.g. the sensitivity, the demands on mechanical stability, temperature constancy etc. The measuring range is determined by the spectral properties of the lamp and monochromator and this unit has been thoroughly examined by determining the contrast at many interference periods in the instrument and also by means of a birefringent interferometer. The lower limit is set, by the photometric accuracy, to 3×10^{-8} in refractive index difference and the upper, by the monochromaticity of the spectral line, to 9×10^{-3} with a cell 30 mm long. Various experiences obtained during measurements on gases are reported. For liquids, the system heavy—light water has been thoroughly examined. The treatment of the water to give reproducible results is discussed. The refractive index Δn difference between heavy and ordinary water has been measured at two temperatures, and the following equations valid at 20.0°C have been obtained: $-\Delta n \times 10^7 = 48662x - 143x^2$ for $\lambda = 5461$ A and $-\Delta n \times 10^7 = 52960x - 174x^2$ for $\lambda = 4358$ A (x is the excess concentration of deuterium in the sample relative to the content in ordinary water). These equations have been compared with equations which were theoretically calculated using the Dale—Gladstone formula and the volumes of the solution and its components. The agreement shows that the refractive index of the solution is correctly described by this law. For the temperature derivative, the following values have been obtained: $d(\Delta n)/dt = 25.0x \times 10^{-6}$ for $\lambda = 5461$ A and $d(\Delta n)/dt = 26.0x \times 10^{-6}$ for $\lambda = 4358$ A. The determination of heavy water concentrations using the phase contrast refractometer gives an accuracy of 0.002 mol % in the low concentration region where the limit is set by the reproducibility of the treatment of the water. This corresponds to 15×10^{-8} in refractive index. For higher concentrations, the accuracy diminishes due to the errors in the equations given above, and, in the highest region, it is 0.02 mol %. The influence of pressure on the refractive index was also examined for ordinary water and heavy water. The values obtained for the isothermal compressibility are for ordinary water 44.9×10^{-11} m²/N and for heavy water

45.9×10^{-11} m^2/N. These values are compared with others determined by means of other methods and it is seen that the agreement is good. In this work, Dale–Gladstone's law was also used and was found to give a good description of the phenomena.

535.8

12472 AN INTEGRATING U.V. RADIATION METER EMPLOYING A PHOTOELECTRIC PRINCIPAL.

W.Eschke.
Exper. Tech. der Phys., Vol. 8, No. 1, 14-18 (1960). In German.

The instrument includes a CdS photocathode (maximum spectral sensitivity at about 5100 A) and a cold cathode thyratron relaxation oscillation circuit. A gelatine-sodium salicylate fluorescent layer, between the input transmission filter and the u.v. radiation cut-off filter, serves as a wavelength shifter. The relaxation oscillation frequency can be compared with a constant calibration frequency and is a measure of the integrated radiation intensity.

I.C.Demetsopoullos

535.8

12473 AN EMPIRICAL ASSESSMENT OF THE EFFECT OF QUENCHING ON THE INFRARED OPTICAL PROPERTIES OF POLYTRIFLUOROCHLOROETHYLENE.

J.R.Jenness, Jr.
J. Opt. Soc. Amer., Vol. 50, No. 7, 738-9 (July, 1960).

Slow cooling of PTFE from above 215°C causes microcrystals to form within the material, and its transmission in the visible and infrared is impaired. Quenching to 150° C preserves the amorphous form provided the quenching time is less than a minute. Some methods are given for making lenses and windows by moulding.

C.Hilsum

535.8

12474 INFRARED TRANSMISSION OF TRIFLUOROCHLOROETHYLENE.

T.Wentink, Jr and C.E.Martin.
J. Opt. Soc. Amer., Vol. 50, No. 7, 741-2 (July, 1960).

This plastic has an infrared transmission very similar to that of quartz. The transmission is dependent on heat treatment, and can be improved by quenching from above 211°C rapidly to room temperature.

C.Hilsum

535.8

12475 THE ADJUSTMENT OF THE ORIENTATION OF A PLANE SURFACE BY AN AUTO-COLLIMATION METHOD.

H.Juricic.
Rev. Opt., Vol. 38, No. 4, 202-4 (April, 1959). In French.

In setting up specimens for the measurement of reflection coefficient with a monochromator as a light source, it may be difficult to determine the normal by the standard auto-collimation technique. A modified method is described which does not require the reflected beam to be found within the monochromator. An auxiliary optical system is used, with a 45° semi-reflecting mirror to produce a second beam. Practical details are given.

R.W.Fish

535.8 : 539.1.07

12476 A THERMAL ENCLOSURE FOR A MICROSCOPE.

A.Bonetti and A.E.Sichirollo.
"Particle photography" Conference. Montreal, 1958 (See Abstr. 2261 of 1960) p. 354-6. In French.

To reduce the considerable fluctuations in the position of the image seen in microscopes with fluid drives, produced by thermal gradients, an isothermal enclosure was designed. In particular the construction of such a unit for the Koristka MS-2 microscope is described and the improvement in the position stability of the image discussed.

S.J.St-Lorant

535.8 : 539.1.07

12477 PRECISION MEASUREMENTS ON THE Z-AXIS OF A MICROSCOPE.

D.Heughebaert and J.Heughebaert.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 359-64. In French.

A considerable increase in the accuracy of measurements in the vertical plane is obtained if the relative distance between the objective and the eyepiece is made variable, the distance between the objective and the plate remaining unchanged. A device based on this principle is described, its use and the attainable accuracy are illustrated for a number of cases.

S.J.St-Lorant

535.8 : 539.1.07

A SCANNING MICROSCOPE FOR PARTICLE TRACK ANALYSIS. See Abstr. 12790

535.8 : 539.1.0

AN IMAGE ROTATOR FOR MEASUREMENTS IN NUCLEAR EMULSIONS. See Abstr. 12789

535.8 : 539.2

12478 CO-ORDINATION OF LIGHT AND ELECTRON MICROSCOPY.

V.E.Cosslett.
Nature (London), Vol. 186, 672-3 (May 28, 1960).

This is a report of a symposium of the same title held at the University of Leeds on March 31 and April 1, 1960, jointly by the Royal Microscopical Society and the Electron Microscopy Group of the Institute of Physics. A short summary is given of each of the main papers: "The complementary nature of light and electron microscopy" by R.Barer; "Co-ordination of light and electron microscopy in plant cytology" by I.Manton; "Correlation of optical and electron microscopy as exemplified by studies of rat testis" by D.Lacy; "Cross-banding and structure of fibres" by K.M Rudall; "Examination of paper surfaces" by D.H.Page; "Optical and electron metallography" by J.Nutting and P.Kelly; "Complementary light and electron microscope investigations on the habit and structure of crystals, with particular reference to long chain compounds" by A.Keller and D.C.Bassett; "Methods involved in the comparative use of optical and electron microscopical techniques" by Anna Cosslett; and the summing-up by V.E.Cosslett.

V.E.Cossle

535.33 : 536

MAXIMUM POSSIBLE SENSITIVITY OF A SELECTIVE OPTICO-ACOUSTIC RECEIVER. See Abstr. 12526

535.33 : 536.

SELECTIVE OPTICO-ACOUSTIC RECEIVER WITH AN ELECTRODYNAMIC MICROPHONE. See Abstr. 12527

535.33 : 539.1

12479 CONTINUED EXPERIMENTS ON THE EXCITATION OF SPECTRA BY HIGH FREQUENCY PULSES.

L.Minnhagen, B.Petersson and L.Stigmark.
Ark Fys., Vol. 16, Paper 45, 541-4 (1960).

The experiments previously described (see Abstr. 5762 of 195 have been continued, and a new power amplifier containing two 25 kW triodes was constructed to increase the high-frequency powe An attempt was made to obtain a coupling that was as insensitive as possible to the particular loading represented by the plasma in the discharge tube with its varying degree of ionization. The transfer of large high-frequency pulse powers from the generator to the gas in the discharge tube was also investigated. Experiments with Xe are described.

535.3

12480 THE USE OF SCATTER DIAGRAMS IN EMISSION SPECTROSCOPY.

G.Holdt and A.Strasheim.
Appl. Spectrosc., Vol. 14, No. 3, 64-72 (June, 1960).

The necessity to employ two-dimensional statistical methods in emission spectroscopy and the dependence of variance of ΔY, i.e. of the logarithm of the intensity ratio of an analysis-internal standard line pair, on correlation and regression are pointed out. To investigate the statistical behaviour of intensity ratios or the correlation of other quantities, the scatter diagram method and its improvement by the contour ellipse are described. Examples of various applications are given and the calculation of the "Complete Statistical Analysis" is described. The completion of the scatter diagram method by statistical test methods is illustrated by examples.

535.3

12481 DETERMINATION OF THE ABSOLUTE VALUES OF T INTENSITY PARAMETERS IN AN INFRARED ABSORP TION SPECTRUM WHEN SECULAR DISTORTIONS ARE ABSENT.

V.M.Chulanovskii, I.V.Peisakhson and D.N.Shchepkin.
Optika i Spektrosk., Vol. 7, No. 6, 763-9 (Dec., 1959). In Russian.

The secular distortions, due to inertia of the amplifying and recording parts of current infrared single-beam spectrophotomete can be avoided as follows. Recording is started with the beam cut off in order to obtain the zero level of intensity. Then a cell containing pure solvent is placed in the beam. As soon as the recorde pen starts to draw a straight line parallel to the zero level, a cell containing solution is introduced into the beam and the correspond intensity is recorded. When the recorder pen begins again to draw a line parallel to the zero level, the beam is cut off completely. The secular distortions are thus avoided entirely and the spectral parameters can be found more reliably. Description is given of

ee methods of determination of spectral parameters, such as the
ical density at the band maximum, the integral density and half-
th of the band, all corrected for distortions due to the mono-
omator. A.Tybulewicz

535.33

12482 DETERMINATION OF THE ABSOLUTE VALUES OF THE INTENSITY PARAMETERS IN AN INFRARED
SORPTION SPECTRUM WHEN SECULAR DISTORTIONS ARE
SENT. II. V.M.Chulanovskii, I.V.Peisakhson and D.N.Shchepkin.
tika i Spektrosk., Vol. 8, No. 1, 57-60 (Jan., 1960). In Russian.

For Pt I, see preceding abstract. The present paper reports
experimental comparison of these methods and shows that they
give practically the same values of the optical density at the
sorption maxima. A.Tybulewicz

535.33

12483 A METHOD OF TRANSFORMING SPECTRAL LINE PROFILES AND ITS USE IN MEASUREMENT OF
MPERATURE AND OTHER PARAMETERS OF A LIGHT SOURCE.
P.Chaika and É.E.Fradkin.
tika i Spektrosk., Vol. 7, No. 6, 820-3 (Dec., 1959). In Russian.

It is sometimes possible to determine the parameters of a pro-
e of one line if the true profile (i.e. the profile observed at the
ry slit of a spectrometer) of another line is known. A certain
lationship is assumed between the true profiles, k_1 and k_2, of the
o lines. The profiles at the exit slit of the spectrometer (known
"real" profiles, g_1 and g_2) are recorded. If the frequencies are
se enough, then, if k_1 is known, k_2 can be found by a mathematical
ocedure described in detail by the authors. A.Tybulewicz

535.33

12484 APPARATUS FOR OBTAINING RAMAN SPECTRA OF SOLID SUBSTANCES AT LOW TEMPERATURES.
Schrader, F.Nerdel and G.Kresze.
turwissenschaften, Vol. 47, No. 9, 198-9 (1960). In German.

The specimen disk is held in a cooled block beneath a Dewar
ssel; it is observed in transmitted light, interference filters being
ed so that lattice vibrations as close as 40 cm^{-1} may be photo-
aphed. G.F.Lothian

535.33

12485 A METHOD FOR DETERMINING THE STRAY LIGHT IN PRISM SPECTROPHOTOMETERS.
Fröhlich and M.Schmuntzsch.
tik, Vol. 17, No. 2, 65-9 (Feb., 1960). In German.

This treatment allows numerical calculation of the relative
ray intensity and its spectral response. This is obtained by
suming a special scattering function and by normalizing to a
velength, suitable for measuring.

535.33

12486 DETERMINATION OF THE PARAMETERS WHICH GIVE THE TRUE PROFILES OF ABSORPTION BANDS.
.Peisakhson.
ptika i Spektrosk., Vol. 8, No. 1, 116-17 (Jan., 1960). In Russian.

A summary of a paper presented at the Conference on the
eory of Spectroscopic Instruments (Leningrad, 5-7 March, 1959).
e instrument function of an aberrationless monochromator is
presented approximately by a triangular profile and relationships
tween the true and measured parameters of isolated absorption
nds are derived. A.Tybulewicz

535.33

12487 MEASUREMENTS OF THE "INSTRUMENT FUNCTION" OF AN IKS-11 SPECTROMETER.
D.Dmitrievskii and V.A Nikitin.
ptika i Spektrosk., Vol. 8, No. 1, 117-18 (Jan., 1960). In Russian.

A summary of a paper presented at the Conference on the
eory of Spectroscopic Instruments (Leningrad, 5-7 March, 1959).
sing the 1.014 μ (9859 cm^{-1}) line from a mercury lamp as a
onochromatic source, the authors determined the instrument-
nction profile of an IKS-11 spectrometer. A.Tybulewicz

535.33 : 532.7

12488 EXPERIMENTAL DETERMINATION OF THE INFRA-RED ABSORPTION-BAND PARAMETERS IN LIQUIDS.
N.Shchepkin.
ptika i Spektrosk., Vol. 8, No. 1, 118-20 (Jan., 1960). In Russian.

A summary of a paper presented at the Conference on the
eory of Spectroscopic Instruments (Leningrad, 5-7 March, 1959) Describes an experimental check of Peisakhson's relationships between the true and measured parameters of isolated absorption bands. A.Tybulewicz

535.33

12489 THE RATIO OF THE SIGNAL DUE TO THE COMPONENT BEING INVESTIGATED TO THE SIGNAL OF THE TOTAL RADIATION FLUX IN INFRARED GAS ANALYSERS. A.O.Sall'.
Optika i Spektrosk., Vol. 8, No. 1, 135-7 (Jan., 1960). In Russian.

The sensitivity of infrared analysers can be increased by the use of optico-acoustic receivers, by varying periodically the amount of the gas component to be determined in the paths of both radiation beams, or by varying periodically the gas temperature in a selective source. A.Tybulewicz

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics,
Liquid State, or Gaseous State)

535.4

12490 RESOLUTION OF SPECTRAL LINES OF UNEQUAL INTENSITY IN GRATING, REFLECTING ECHELON AND PRISM. K.C.Chaturvedi.
Optik, Vol. 17, No. 2, 70-4 (Feb., 1960).

Discusses the dependence of resolving power on the intensity ratio of the two lines to be resolved, on the degree of resolution desired, when natural line width is negligible.

535.41 : 531.71

12491 A THICKNESS MEASUREMENT TECHNIQUE USING A THREE-BEAM INTERFERENCE ARRANGEMENT FOR OBJECTS OF THICKNESS LESS THAN 1 MICRON. H.Westmeyer.
Exper. Tech. der Phys. Vol. 8, No. 1, 18-25 (1960). In German.

It is often required to know the thickness of an ultramicrotome section. An application of the Zernike three-beam interference method for doing this measurement is described. The elementary theory of the method is reviewed, adjustments are described and a simple set-up is discussed. S.Tolansky

535.41

12492 COLOURS OF WRINKLED TRANSPARENT FILMS ON METAL SURFACES.
K.D.Sinel'nikov, I.N.Shklyarevskii and I.V.Gladkova.
Optika i Spektrosk., Vol. 7, No. 6, 846-8 (Dec., 1959). In Russian.

Wood (1904) found that a wrinkled layer of collodion on a polished silver surface exhibits strong colours when illuminated normally with white light. These colours are visible at angles of 70-90° to the normal and they appear stronger when observed through a suitably oriented nicol. When the nicol is rotated by 90° the complementary colours are observed, i.e. one half of the spectrum is polarized in one plane and the other at right angles to it. Wood proved conclusively the interference nature of the observed colours but did not explain the brightness of the colouring and the polarization effects. The present note explains the latter two phenomena in terms of light reflection at large angles of incidence by wrinkle-free portions and in terms of a phase-shift between the p- and s-components. Experiments are reported which confirm the explanation. A.Tybulewicz

535.42

12493 AN APPROXIMATES SOLUTION FOR THE DIFFRACTION OF A PLANE MONOCHROMATIC WAVE AT A SLIT.
F.Loges.
Optik, Vol. 17, No. 2, 75-83 (Feb., 1960). In German.

An approximate solution is presented of the two-dimensional problem of the diffraction of a plane-polarized, plane wave incident in any manner on a slit. The approximation, which is given in the form of integrals of the wave-equation in the coordinates of the elliptic cylinder, does not conform to the boundary condition. The resulting error is made negligible by means of suitable integrals of the emergent waves at the edges of the slit. Applications are indicated for normal incidence.

535.42 : 534.21

12494 DIFFRACTIONAL LIGHT MODULATOR WITH OPPOSED ULTRASONIC RADIATORS. Yu.V.Popov and I.I.Adrianova.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 4, 813-16 (April 1, 1960). In Russian.

The different types of high frequency diffraction light modulators are described and two systems consisting of two or four opposed ultrasonic radiators are suggested. The frequency characteristics of the barium titanate radiators are determined, and the properties required of the liquid filling the modulator are listed. Suitable liquids are xylene, and 17% ethyl alcohol in water.

R.F.S.Hearmon

535.43

12495

A VISUAL NEPHELOMETER.

V.N.Tsvetkov and V.S.Skazka.

Optika i Spektrosk., Vol. 7, No. 6, 808-12 (Dec., 1959). In Russian.

Describes a visual nephelometer and its use in the determination of the scattering indicatrix of solutions of high molecular weight compounds. The results obtained for two solutions of polystyrene in benzene agree satisfactorily with those already reported.

A.Tybulewicz

535.43

12496

DETERMINATION OF PARTICLE SIZE BY THE SCATTERING OF LIGHT. I. FORMULAE AND NOMOGRAMS FOR THE CALCULATION OF PARTICLE RADIUS FROM THE OPTICAL DENSITY AND FROM THE INTENSITY OF THE SCATTERED LIGHT.

I.Ya.Slonim.

Optika i Spektrosk., Vol. 8, No. 1, 98-108 (Jan., 1960). In Russian.

Shifrin's theory of scattering (1951) is used to deduce formulae and to construct nomograms which can be used to determine particle size in disperse systems in which the electrical properties of the particles differ only a little from the corresponding properties of the medium.

A.Tybulewicz

535.5

12497

CERTAIN GENERAL RULES REGARDING THE REFLECTION OF LIGHT FROM CRYSTALS.

F.I.Fedorov.

Kristallografiya, Vol. 3, No. 3, 322-4 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 325-7 (May-June, 1958).

It is established theoretically that, when light is reflected from crystals of any type (transparent, opaque, magnetic, etc.), for every direction of the normal in the incident wave there exists an unique pair of orthogonal directions of polarization in the incident wave which corresponds to another pair of orthogonal directions of polarization in the reflected wave. For these directions of polarization, the reflection coefficients assume maximum and minimum values.

535.55

12498

DETERMINATION OF THE OPTICAL ANISOTROPY OF MACROMOLECULES IN A SYSTEM EXHIBITING THE SHAPE EFFECT. I.

E.V.Frisman and É.N.Arkhipova.

Zh. tekh. Fiz., Vol. 29, No. 2, 198-206 (Feb., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 2, 171-8 (Feb., 1959).

A discussion of the theory of streaming double refraction of macromolecular solutions is presented. It is assumed that this can arise from the natural anisotropy of the molecules and the shape effect. The latter occurs when asymmetrical particles of refractive index n_k are oriented in a medium of refractive index n_s. It is stated that the shape effect gives rise to a parabolic dependence of the dynamic optical constant [n] on $(n_k - n_s)$ and an increase in the ratio $[n]/[\eta]$ with increase in molecular weight M. The constant [n] is defined as $(\Delta n/Gc\eta_0)_{\substack{G \to 0\\ c \to 0}}$, where Δn is the double refraction of a solution of concentration c due to a gradient G and η_0 is the solvent viscosity; $[\eta]$ is the limiting viscosity number. The shape effect is also responsible for the dependence of the sign of Δn on G and on c. For small gradients for which no molecular deformation occurs

$$\frac{[n]}{[\eta]} = \text{const.}\,(\alpha_1 - \alpha_2) + \phi\,(n_k - n_s)^2 f\left(\frac{M}{[\eta]}\right),$$

where ϕ is a constant called Flory's constant, and $(\alpha_1 - \alpha_2)$ is the difference in the polarizabilities of a molecular segment. A graph of $[n]/[\eta]$ against $f\left(\frac{M}{[\eta]}\right)$ gives a straight line from the slope of which ϕ can be found and whose intercept on the $[n]/[\eta]$ axis gives $(\alpha_1 - \alpha_2)$. The results of experiments made on polystyrene solutions in dioxane in which the shape effect is important are given. For solutions having values of M in the region 10^5 to 7×10^5 the double refraction Δn was negative and directly proportional to G. For higher values of M ($M \cong 1.5 \times 10^6$) at low concentrations and small gradients, Δn was positive but became negative as G increased. Th higher the concentration the lower the value of G at which the chang occurred. Concentrated solutions gave negative values of Δn for all values of G. Graphs of [n] against concentration are given: they ar linear with a negative slope. The value of [n] is negative for small values of M and positive for larger values ($> 7 \times 10^5$). These results agree with the theory. The value of $\alpha_1 - \alpha_2$ is given as -148×10^{-25} cm^3 and this agrees well with the value for polystyrene bromoform (-144×10^{-25}) where the shape effect is absent. Flory's constant ϕ is 2.35×10^{23} litre mole^{-1}.

H.G.Jerrar

535.55

12499

DYNAMIC DOUBLE REFRACTION OF SOLUTIONS OF LOW MOLECULAR WEIGHT FRACTIONS OF POLYSTYRENE IN BUTANONE. II.

É.V.Frisman, G.I.Garmonova and V.E.Bÿchkova.

Zh. tekh. Fiz., Vol. 29, No. 2, 207-11 (Feb., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 2, 179-83 (Feb., 1959).

Gives the results of an experimental study. With high-molecula weight fractions previously studied [Tsvetkov and Petrova, Zh. tekh Fiz., Vol. 14, 289 (1944)] the double refraction Δn is positive but th present work shows Δn to be negative. The results are in agreemer with the theory given in Pt I. From the data the optical anisotropy $(\alpha_1 - \alpha_2)$ of the molecular segments is found to be -152×10^{-25} cm and Flory's constant ϕ is 2.40×10^{23} litre mole^{-1}. The sign of the double refraction was dependent on the concentration.

H.G.Jerrard

535.5

12500

DYNAMIC DOUBLE REFRACTION DUE TO THE SHAP OF MACROMOLECULES IN A SOLUTION UNDER CONDITIONS OF DIFFERENT CONCENTRATIONS AND SHEAR STRESSES. III.

É.V.Frisman and V.N.Tsvetkov.

Zh. tekh. Fiz., Vol. 29, No. 2, 212-23 (Feb., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 2, 184-93 (Feb., 1959).

Further results are given for the streaming double refraction of samples of polystyrene in dioxane. The theory (see Pt I) is extended to include the action of the shape effect at large gradients. The extension uses Kuhn's dumb-bell [W.Kuhn and H.Kuhn, Helvetic chimica acta, Vol. 26, 1395 (1943); Vol. 28, 1533 (1945); H.Kuhn Helvetica chimica acta, Vol. 31, 1677 (1948)] for soft chains in solution. The theoretical conclusions are compared with the experimental data. It appears that the theory is satisfactory for low gradients but the deformation of the macromolecules at high gradie is less than the dumb-bell theory of Kuhn predicts. An anomalous dependence of the angle of extinction on the velocity gradient when the double refraction changes sign is found. The investigation show that the dependence of the double refraction on concentration is determined by the hydrodynamic and optical interaction of the molecules. The optical interaction is characteristic only of solutio in which the shape effect is present. The theory given for the concentration dependence of the shape effect is in good agreement with the experimental results.

H.G.Jerrar

535.5

12501

DOUBLE REFRACTION IN FLOWING SOLUTIONS OF POLY-PARA-TERTIARY BUTYLPHENYLMETHACRYLATE. I. THE REGION OF SMALL VELOCITY GRADIENT:

V.N.Tsvetkov and I.N.Shtennikova.

Zh. tekh. Fiz., Vol. 29, No. 7, 885-95 (July, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New Yo Vol. 4, No. 7, 800-9 (Jan., 1960).

The birefringence and viscosity of solutions of poly-para-terti butylphenylmethacrylate were measured in various solvents under small velocity gradient. The relation between the dynamic optical constant [n] and the refractive index of the solvent was parabolic a found in earlier experiments [Abstr. 8137 of 1956; 7798 of 1957; Journal of Polymer Science, Vol. 23, 151 (1957)] on polystyrene an polymethylmethacrylate, in agreement with theory. For three different solvents the relation between $\frac{n}{\eta} \cdot \frac{45 \quad n_s kT}{4\pi(n_s^2 + 2)^2}$ and $\frac{M}{\eta}$ was linear for values of M(molecular weight) varying from 28 × 1 to 0.2×10^6 again in agreement with theory. The degree of asymmetry p of the molecular coil was found by both the above methods which independently gave the same result p = 3.5, somewhat larger than the values for polystyrene and PMMA in the previous work. It is thought that this may be connected with the presence of large

le groups in the molecular chain. The molecular anisotropy did
t differ from solvent to solvent but there was a decrease in form
isotropy with increase in concentration in solvents in which
$\neq n_s$. This was in agreement with theory. R.G.C.Arridge

COLORIMETRY . PHOTOGRAPHY

77 : 539.1.07

PARTICLE PHOTOGRAPHY CONFERENCE. PREPARATION
ND SENSITIZATION OF EMULSIONS. LATENT IMAGE.
EVELOPMENT. ACTION OF PARTICLES. See Abstr. 12730-99

77

12502 CONTRAST TRANSFER FUNCTION OF THE LIGHT DIFFUSION IN PHOTOGRAPHIC EMULSIONS.
O.Hendeberg.
'k. Fys., Vol. 16, Paper 38, 417-56 (1960).

Due to the method employed, the photographic emulsion preserves
e sinusoidal shape and linearity of a sinusoidal line pattern. This
ables the experimental determination of the Fourier transform
$'_{em}(N)|$ of the light distribution function produced by an emulsion.
sinusoidal line pattern with several previously chosen space
equencies is photographed on an emulsion, whereby the transform
: the combination of optical system and emulsion is obtained. The
luence of the optics is eliminated numerically by means of experi-
ental knowledge of its Fourier transform $|F_{opt}(N)|$. The function
$'_{em}(N)|$, however, is dependent on the emulsion-developer combin-
ion, the spectral range used in the exposure of the emulsion, the
orage of the film, the particular batch of the emulsion which is
vestigated, etc. It is therefore difficult in general to fit a one-
rameter function to the light diffusion distributions. The assump-
ns of Frieser and Sayanagi fit best for certain combinations while
nctions of the type $[1 + cx^2]^{-1}$ are best for others. These inverses
the experimental Fourier transforms $|F_{em}(N)|$ are obtained by
eans of an electronic calculating machine.

77

12503 THE CONTRAST TRANSFER OF PERIODICAL STRUCTURES IN A PHOTOGRAPHIC EMULSION
EVELOPED WITH ADJACENCY EFFECTS. L.O.Hendeberg.
'k. Fys., Vol. 16, Paper 39, 457-68 (1960).

The adjacency effect is examined by the method of contrast
ansfer, in this case by projecting a periodical sinusoidal line
ttern by an optical system onto a photographic emulsion. Remark-
le differences in the contrast transfer functions of the emulsion
e found to occur between development when adjacency effects are
gorously avoided and when such are present. Examination shows
maximal effect at 20-30 lines/mm. Even at 80-100 lines/mm an
jacency effect often exists.

77

12504 PHOTOGRAPHIC RESOLVING POWER AS A FUNCTION OF EMULSION THICKNESS AND LENS APERTURE.
Narath and G.Schimmel.
wiss. Photogr., Vol. 53, No. 10-12, 181-201 (1959). In German.

Results of measurements of resolving power are given for two
pes of emulsion. For each emulsion, the effect of changing the lens
erture and the colour of the illumination are shown. A series of
ms with the emulsion layers in the range 6-35 μ were used to
termine the variation with emulsion thickness. An explanation
the results is given in terms of the resolving power of the emul-
on "by itself" and the geometrical circle of confusion due to the
ns. 19 references are given. R.W.Fish

77

12505 SOME RECENT RESULTS CONCERNING THE THEORY OF DEVELOPMENT. H.Frieser.
article photography" Conference. Montreal, 1958 (see Abstr. 2261
1960), p.34-9. In French.

A brief review of some important aspects of the action of the
veloper. Considered in particular is the relation between the state
dissociation of the developing agent and the efficacy of the developer,
solvent action of the developer and the distinction between chemi-
l and physical development, the mechanism of chemical develop-
ent and the estimation of the number of centres present in the
ent image. S.J.St-Lorant

77

12506 A STUDY OF THE FORMATION OF THE LATENT IMAGE BY THE SIMULTANEOUS ACTION OF PULSED LIGHT AND PULSED ELECTRIC FIELDS. J.F.Hamilton.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960), p. 21-9. In French.

Thin pellicles of special coarse-grained photographic emulsion were simultaneously exposed to short intense light flashes and to strong pulsed electric fields. It was found that the sensitized centres from which grain growth takes place were all localized in the more electropositive region of the grain, indicating that the formation of such centres appears to be due to the trapping of migrating photoelectrons by imperfections in the lattice of the silver halide grain. The phenomenon is illustrated for a number of variations in the values of the experimental parameters, and its theoretical significance discussed. S.J.St-Lorant

HEAT . RADIATION

536.2

12507 HEAT TRANSFER. E.R.G.Eckert, J.P.Hartnett, T.F.Irvine, Jr, and E.M.Sparrow.
Industr. engng Chem., Vol. 52, No. 4, 327-39 (April, 1960).

Review of recent literature (books, periodicals, conference proceedings and reports) on the following: conduction, channel flow, boundary layer flow; flow with separated regions; transfer mechanisms; natural convection; convection from rotating surfaces; combined heat and mass transfer; change of phase; radiation; liquid metals; low density heat transfer; measurement techniques; heat exchangers; aircraft, missiles and satellites; electric equipment. The bibliography (arranged under the foregoing headings) comprises 301 items.

536.2 : 518

12508 ON THE PROPAGATION OF ROUND-OFF ERRORS IN THE NUMERICAL INTEGRATION OF THE HEAT EQUATION. A.N.Lowan.
Math. Comput., Vol. 14, 139-46 (April, 1960).

536.2 : 539.17

12509 CONDUCTION HEAT-FLOW TRANSIENTS. J.S.Hucks and A.L.Gaines.
Nucleonics, Vol. 18, No. 4, 66-7 (April, 1960).

Nucleonics Data Sheet. No. 37. A nomogram assisting the calculation of thermal stress and heating and cooling rates in shells for which the ratio of radius of curvature to wall thickness is large. Both step and ramp changes are considered. R.D.Smith

536.2

12510 THE EFFICIENCY OF COMPOSITE FINS. J.J.Barker.
Nuclear Sci. Engng, Vol. 3, No. 3, 300-12 (March, 1958).

The fin efficiency, defined as the ratio of the average temperature of the surface of the fin to the temperature at its base, is derived for flat and for circular fins composed of two or more materials (such as copper clad with stainless steel), for the usual conditions of constant heat transfer coefficient h and uniform ambient temperature. The exact solution is in the form of an infinite series, but the terms beyond the first are usually negligible. For most cases of interest, the fin efficiency η is shown to be approximated closely by the familiar equation $\eta = (\tanh \alpha L)/\alpha L$, where $\alpha = (hP/\bar{k}A)^{1/2}$, and L, P, and A are, respectively, the length, perimeter, and cross-sectional area of the fin, and k is the volumetric average thermal conductivity of the fin, $\bar{k} = \Sigma k_i A_i/A$ where k_i and A_i are the conductivity and cross-sectional area of the region i.

536.2

12511 THE TEMPERATURE FIELD IN A MASSIVE [BLOCK OF MATTER] DUE TO [HEATED] TUBES.
L.M.Al'tshuler.
Zh. tekh. Fiz., Vol. 27, No. 7, 1495-502 (July, 1957). In Russian.

The heating of a solid block by means of a single tube-shaped heater in its interior is described in a simplified way by regarding the block as semi-infinite in one dimension and infinite in the other two, by representing the heater as a point source in two dimensions and by neglecting the effect of temperature on the thermometric conductivity of the solid material. With these simplifying assumptions the inhomogeneous equation of thermal conduction is solved by the method of Green's functions. Solutions are obtained for steady and for transient temperatures and for boundary conditions of a general kind. Results are given in analytical form supplemented by numerical tables. The solutions of the above problem can be used for finding the temperature distribution in a system in which the block is heated by two or more tube-shaped heaters. The appropriate distribution of temperature is obtained by simple superposition of the temperatures arising from a single heater in absence of the others. R.Eisenschitz

536.2 : 533.6

12512 AN APPROXIMATE METHOD FOR CALCULATING THE THERMAL BOUNDARY LAYER. L.M.Zÿsina-Molozhen.

Zh. tekh. Fiz., Vol. 29, No. 5, 632-9 (May, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 564-70 (Nov., 1959).

A semi-empirical method for calculating the distribution of local values of heat transfer coefficient over a curvilinear surface. The conditions are limited to low values of the wall temperature and the boundary layer temperature almost equal to the wall temperature. Under these conditions the results agree well with experiment. T.C.Toye

536.2 : 539.17

12513 HEAT TRANSFER IN HETEROGENEOUS CIRCULATING-FUEL REACTORS. H.F.Poppendiek and L.D.Palmer.

Nuclear Sci. Engng. Vol. 3, No. 1, 85-106 (Jan., 1958).

Radial temperature distributions within the cores of heterogeneous circulating-fuel reactors having elementary channel and circular pipe geometries are described mathematically; uniform and nonuniform radial volume-heat-source distributions are considered. Solutions for cores with uniform volume-heat source distributions are tabulated so that detailed radial temperature profiles can be determined within fuels which are being uniformly cooled at the core walls. A derivation is presented which describes the heat transfer within a reactor core when walls are being non-uniformly cooled along its length; volume heat sources also exist within the core walls and coolant.

536.2 : 539.215

12514 HEAT-MASS EXCHANGE IN A GRANULAR LAYER. IV. LOCAL COEFFICIENTS OF HEAT-MASS EXCHANGE IN A LAYER OF BALLS.

M.É.Aérov, N.I.Nikitina, S.S.Trainina and I.V.Gusev.

Zh. tekh. Fiz., Vol. 29, No. 7, 924-7 (July, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 7, 837-40 (Jan., 1960).

For previous parts, see Zh. tekh. Fiz., Vol. 26, No. 6, 1233-42, 1243-50 (June, 1956). Polished steel balls, 19 mm diameter, were arranged in a hexagonal container with 10 layers of 7 balls in each horizontal layer. A stream of air was passed through from the bottom. The central ball in the next to the top layer had removable inserts of naphthalene which were weighed on a microbalance before and after the passage of air, and the coefficients of mass transfer were calculated from the loss of weight. Results are given for Re = 40, 300 and 3000. S.Weintroub

536.2 : 539.17

12515 HEAT CONDUCTION IN INTERNALLY COOLED NUCLEAR REACTORS. R.A.Axford.

Nuclear Sci. Engng, Vol. 4, No. 2, 139-54 (Aug., 1958).

Several problems in heat conduction relating to internally cooled nuclear reactors are solved by means of successive Schwarz-Christoffel transformations. Formulae are derived for the computation of the thermal resistance between hot and cold fluids flowing through a solid in parallel channels of variously shaped cross-sections, including the square, rectangle, and an oval approximation to the circle and the ellipse.

536.2

12516 THE CALCULATION OF HEAT FLOW IN MELTING SOLIDS. M.Lotkin.

Quart. appl. Math., Vol. 18, No. 1, 79-85 (April, 1960).

536.2

12517 HEAT TRANSFER IN FULLY DEVELOPED FLOW BETWEEN PARALLEL PLATES WITH VARIABLE HEAT SOURCES. A.L.Loeffler, Jr.

Nuclear Sci. Engng, Vol. 2, No. 5, 547-66 (Sept., 1957).

The analyses of Poppendiek and Palmer for laminar and turbulent flow between parallel plates with uniform internal heat generation have been extended to the case of internal heat generati decreasing parabolically with distance from the wall. It is shown that the effect of this nonuniformity is to increase the temperature of the wall with respect to the bulk temperature. Thus, the wall cooling required to maintain a given wall temperature is greater with the nonuniform than with the uniform internal heat generation.

536.2 : 532.

12518 LAMINAR TUBE FLOW WITH ARBITRARY INTERNAL HEAT SOURCES AND WALL HEAT TRANSFER.

E.M.Sparrow and R.Siegel.

Nuclear Sci. Engng, Vol. 4, No. 2, 239-54 (Aug., 1958).

An analysis is made to determined the heat transfer characteristics for laminar flow of a heat generating fluid in a circular tub with wall heat transfer. The internal heat generation is permitted to vary in an arbitrary manner both longitudinally along the tube and radially across the section. In addition, arbitrary longitudinal variations in the wall heat transfer may be present. The results obtained apply along the entire length of the tube, that is in the thermal entrance region as well as far down the tube. Numerical results are evaluated for certain special cases such as uniform and parabolic radial heat source distributions.

536

12519 NEW METHOD OF MEASURING GAS THERMAL CONDUCTIVITY.

R.E.Walker, N.deHaas and A.A.Westenberg.

Phys. of Fluids, Vol. 3, No. 3, 482-3 (May-June, 1960).

A preliminary report on the determination of gas thermal conductivity by measuring temperatures downstream from a line sour of heat in a uniform laminar gas current. A brief description is given of the apparatus; determinations on N_2 and He agree satisfactorily with accepted values. R.F.S.Hearmo

536.

12520 THERMAL CONVECTION AT A MELTING BENZENE SURFACE. J. van der Burgh.

Appl. sci. Res. A, Vol. 9, No. 4, 293-6 (1960).

Heat transfer by thermal free convection at the surface of a sphere has been studied experimentally by melting a sphere of sol benzene in a large quantity of liquid benzene of homogeneous tempe ture. The influence of cold liquid produced by the melting process is taken into account to yield results that are representative for the effect of heat transfer without melting. In the general formula for heat transfer by thermal convection, $\overline{\mathrm{Nu}} = C(\mathrm{GrPr})^{1/4}$, it was established that C = 0.525.

536.

12521 THERMAL TRANSIENTS ASSOCIATED WITH NATURAL CONVECTION.

R.C.L.Bosworth and C.M.Groden.

Austral. J. Phys., Vol. 13, No. 1, 73-83 (March, 1960).

An electrical circuit, equivalent to the thermal processes concerned in the act of setting up a system of natural convection in a fluid, is proposed. This circuit consists of parallel elements, on attributed to convection alone and one to conduction alone. The former consists of a resistance and an inductance in series, the latter of a resistance and a shunt capacity. The nature of the transients associated with each circuit has been derived by Heaviside analysis. Functions, at the most involving no more than two independent variables, are found connecting easily measured characteristics of the transients and the circuit parameters. These function are, it is proposed, to be used to examine experimental thermal transients and through them to examine their circuit parameters.

536.

12522 ATTEMPTS TO MEASURE THE INDUCTIVE ELEMEN ASSOCIATED WITH THE NATURAL CONVECTION OF HEAT. R.C.L.Bosworth.

Austral. J. Phys., Vol. 13, No. 1, 84-94 (March, 1960).

A study has been made of the variation in time of the temperature of a wire immersed in a fluid and heated by a constant electric current. For a given fluid the curve obtained by plotting the ratio of the temperature of the wire to the heat input versus the time is initially the same shape for all rates of heat input. Divergences from the lowest heating rate set in only when the system of convection current sets in. This occurs at earlier times after the commencement of heating the higher the heating rate. Expressions already developed are used to evaluate the resistive, capacitive, and inductive elements required to fit the observed transient curves.

values of the former two types of element are consistent with an med stagnant film of a thickness the order of 1 mm around the ed wire, but the value of the deduced inductive element is some 10^5 greater than that associated with the kinetic energy belonging e system of convection currents.

536.2

2523 AVERAGE AND LOCAL HEAT TRANSFER FOR CROSS FLOW THROUGH A TUBE BANK.

.DeBortoli, R.E.Grimble and J.E.Zerbe.

.ear Sci. Engng, Vol. 1, No. 3, 239-51 (July, 1956).

Heat transfer coefficients have been determined for a cross tube bank by heat and mass transfer techniques for the Reynolds ber range of 35 000 to 80 000. Average heat transfer coefficients e favourably with extrapolations of existing data. Local coeffi- t variations from the average were as great as +80% and −55%.

536.2 : 532.5

MEASUREMENT OF LOCAL HEAT TRANSFER COEFFICIENTS H SODIUM—POTASSIUM EUTECTIC IN TURBULENT FLOW. Abstr. 12409

536.2 : 532.7

THERMAL CONDUCTIVITY OF LIQUIDS AND COMPRESSED ES. See Abstr. 12415

536.2 : 53

STEADY HEAT FLOW. SPHERE AND CIRCLE THEOREMS OLVING SURFACE DISCONTINUITIES OF POTENTIAL. Abstr. 12347

536.3

12524 THERMODYNAMICS OF RADIATIVE EMISSION PROCESSES. M.A.Weinstein.

s. Rev., Vol. 119, No. 2, 499-501 (July 15, 1960).

A basic assumption implicit in the application of thermodynamics he electromagnetic field is that the laws of thermodynamics are ally valid for radiative emission and absorption processes. This ans that a certain minimum amount of entropy must be created by radiative process itself. It is shown, by considering the extreme e in which the spontaneous emission of a natural spectral line is only process taking place, that this assumption is correct, and its validity is essentially a consequence of the uncertainty nciple as expressed by the reciprocal relationship between ural line breadth and lifetime.

536.3

12525 THE PROBLEM OF RADIATION EXCHANGE BETWEEN GREY SURFACES. S.P.Detkov.

tekh. Fiz., Vol. 30, No. 1, 96-104 (Jan., 1960). In Russian.

A new ("generalized") type of flow is defined which facilitates use of the method of multiple reflections to obtain expressions the resultant emission power for a system of two, or three, grey faces. A general expression is also obtained for the case of hanges between any number of grey surfaces provided that they be part of the same spherical surface. G.A.Chisnall

536.3 : 535.33

2526 THE MAXIMUM POSSIBLE SENSITIVITY OF A SELECTIVE OPTICO-ACOUSTIC RECEIVER.

.Pankratov and L.M.Vinogradova.

ika i Spektrosk., Vol. 7, No. 6, 789-97 (Dec., 1959). In Russian.

An optico-acoustic receiver consists essentially of a gas-filled re- ver chamber and a microphone. A selective optico-acoustic receiver an optical microphone (the vibrations of the membrane which ns one of the receiver-chamber walls are measured optically) escribed and its measured properties (the chamber time constant, chamber noise, the sensitivity and the r.m.s. noise of the whole eiver) are discussed. A.Tybulewicz

536.3 : 535.33

12527 A SELECTIVE OPTICO-ACOUSTIC RECEIVER WITH AN ELECTRODYNAMIC MICROPHONE. N.A.Pankratov.

ika i Spektrosk., Vol. 8, No. 1, 109-15 (Jan., 1960). In Russian.

Various properties of selective optico-acoustic receivers with onance electrodynamic microphones were studied. The frequency endences of the receiver sensitivity, the receiver noise and the rophone noise were determined. The threshold sensitivity of the eiver was also found. A.Tybulewicz

536.3 : 621.376.23

12528 CRITERIA FOR THE CHOICE OF A SUPER-CONDUCTING BOLOMETER. B.Lalevic.

J. appl. Phys., Vol. 31, No. 7, 1234-6 (July, 1960).

The usefulness of the superconducting bolometer was recognized a long time ago. All experimental data obtained up to now are far below the calculated value for a sensitivity of such a bolometer, because of the presence of the noise in the transition region of a superconductor. The correlation between the noise and the value of the surface boundary energy (interface between normal and superconducting laminas) is presented and on this basis the criteria for the choice of a superconducting bolometer are given. Attempt is made to evalute the noise on the basis of the Thomas—Fermi approximation.

536.3

12529 TIME DISCRIMINATION IN SOLID-STATE INFRARED QUANTUM COUNTERS. J.V.Jelley.

J. appl. Phys., Vol. 31, No. 7, 1145-6 (July, 1960).

The paper discusses various considerations in the practical realization of the infrared solid-state quantum counter recently proposed by Bloembergen. It is suggested that a high degree of discrimination between the quantum to be counted, and the optical pumping flux, could be attained by a time-sequence switching system; it is estimated that an isolation of ~ 160 dB might be required. The proposal demands that at least one of the levels in the crystal have a long lifetime, and a simple expression is derived for the overall efficiency of the detector in this case. An additional gain in efficiency and isolation would result if "double pumping" were used, with detection in the ultraviolet. In conclusion a suggested layout of components is presented incorporating the switching scheme discussed herein.

536.4

12530 CLASSIFICATION OF WIRE EXPLOSIONS. W.G.Chace and M.A.Levine.

J. appl. Phys., Vol. 31, No. 7, 1298 (July, 1960).

Four types of explosion are considered. I. Melting, with "popping", when the energy is insufficient for complete vaporization. II. Slow explosion, when the slow energy input allows time for distortion while still liquid. III. Fast explosion. IV. Explosive ablation, when the skin is peeled off by electrical and thermal effects. A.G.Gaydon

536.4

12531 THERMAL PROPERTY MEASUREMENTS AT VERY HIGH TEMPERATURES. N.S.Rasor and J.D.McClelland.

Rev. sci. Instrum., Vol. 31, No. 6, 595-604 (June, 1960).

Techniques and apparatus have been developed for determination of thermal expansion, specific heat, and thermal conductivity to as high as 3650°C. To obtain and measure the temperatures required, a graphite tube furnace, a graphite helix furnace, and a photoelectric pyrometer were developed and constructed. The details of their design and their use for property determinations to the destruction temperatures of a variety of refractory materials are described.

536.41 : 539.213

12532 ON THE THERMAL EXPANSION AND GRÜNEISEN FACTOR OF VITREOUS SILICA. D.F.Gibbons.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 246-8 (Oct., 1959).

The expansivity and linear thermal-expansion coefficient of vitreous silica have been measured between 4.2 and 140°K the expansivity $\Delta l/l_{273.2}$ is somewhat greater than the value from previous measurements. This difference may be due to variations in manufacture of such a noncrystalline solid. The Grüneisen factor, γ, is calculated and its variation with reduced temperature T/θ_{∞} is compared with that of silicon and indium antimonide. In contrast to these crystalline solids, the temperature variation of γ for vitreous silica is dictated by the $1/C_V$ term in the temperature region investigated.

536.42

12533 EVAPORATION RATE MONITOR. G.R.Giedd and M.H.Perkins.

Rev. sci. Instrum., Vol. 31, No. 7, 773-5 (July, 1960).

A method for controlling the deposition rate of vacuum deposited films is described. Details are given of the rate sensing device and furnace control system. The control system utilizes a saturable-core reactor driven by the output of the rate monitor. This controls the furnace current, thus completing the system. Operation and calibration of the control system is described and experimental results are tabulated.

536.42

12534 THEORY OF THERMAL PROCESSES DURING LIQUID DRAWING OF WIRE UNDER STEADY-STATE CONDITIONS. G.A.Ostroumov.

Zh. tekh. Fiz., Vol. 29, No. 2, 239-46 (Feb., 1959). In Russian. English translation in: Soviet Physics – Technical Physics (New York), Vol. 4, No. 2, 208-14 (Feb., 1959).

The temperature distribution in a moving rod without phase transformations, a rod undergoing a spontaneous phase transformation or a transformation during cooling, and the application to zone melting, are considered. S.Weintroub

536.42 : 539.17

12535 AN EXPERIMENTAL STUDY OF TRANSIENT BOILING M.W.Rosenthal.

Nuclear Sci. Engng, Vol. 2, No. 5, 640-56 (Sept., 1957).

An experimental investigation of heat transfer to subcooled water under transient conditions has been conducted. Heat was generated electrically in platinum and aluminum ribbons in such a manner as to produce exponentially increasing heat generation rates which simulated reactor excursions. Surface temperature was measured, and the events were photographed with a high-speed camera. The temperature attained by the surface before boiling commenced and the time delay between passage of the boiling point and the beginning of boiling were measured. Heat flux at the beginning of film boiling was obtained. The effects of water temperature, exponential period, and gas concentration were studied. Periods ranged from 5 to 75 milliseconds. The bulk water temperature was varied from 90° F to near the boiling point; in all experiments the water was initially stagnant and at atmospheric pressure.

536.46

12536 OPTICAL METHODS FOR THE STUDY OF FLAMES IN TURBULENT PRE-MIXED GAS STREAMS.

M.D.Fox and F.J.Weinberg.

Brit. J. appl. Phys., Vol. 11, No. 7, 269-73 (July, 1960).

Three optical methods for the investigation of flame processes in turbulent gases are described. All are based on ray deflection by the steep refractive-index gradient occasioned by large temperature and composition changes across the flame front. This is utilized in three different optical systems designed (1) to give a measure of the randomness of orientation of the fluctuating flame front in any locality; (2) to delineate the instantaneous flame-front surface; and;(3) to map time-mean deflection (and hence optical path) distributions. Their purpose and use are discussed and illustrated by examples of the records obtained.

536.52

12537 OPTICAL PYROMETRY IN POLARIZED LIGHT. W.Pepperhoff.

Z. angew. Phys., Vol. 12, No. 4, 168-71 (April, 1960). In German.

By using polarized light at angles of incidence of 80°, the true temperature of glowing metal surfaces may be determined. The emitted polarized light is shown to be "black" at the true temperature, independently of oxide films etc. Practical details are given and results shown for iron, nickel and wolfram surfaces.

R.W.Fish

536.53

12538 INTERPOLATION OF PLATINUM RESISTANCE THERMOMETERS, 20° TO 273.15° K. R.J.Corruccini.

Rev. sci. Instrum., Vol. 31, No. 6, 637-40 (June, 1960).

A numerical method for interpolating the resistance-temperature relation of a platinum resistance thermometer is given. Calibration at three points such as 20°, 90° and 273° K is required. The interpolation is then carried out by reference to the complete resistance–temperature relations of two other slightly different thermometers. Limited tests suggests that it is possible to achieve a temperature scale in this way using commercially available thermometers that is reproducible within 0.001 deg, provided the Callendar–van Dusen constants and the residual resistance ratio are sufficiently restricted.

536.55 : 534.22

SPECTROSCOPIC TEMPERATURE MEASUREMENTS IN A SHOCK TUBE USING CN AS A THERMOMETRIC MOLECULE. See Abstr. 12455

536.6 : 539.2

HEAT CAPACITY STUDY OF THE MOVEMENT OF THE AMMONIUM ION IN AMMONIUM STANNICHLORIDE AND STANNIBROMIDE BY COMPARISON OF THE HEAT CAPACITIES OF THE AMMONIUM, RUBIDIUM AND POTASSIUM SALTS. See Abstr. 11582

THERMODYNAMICS

536.

12539 PROOF OF CARATHÉODORY'S LOCAL THEOREM AN ITS GLOBAL APPLICATION TO THERMOSTATICS.

B.Bernstein.

J. math. Phys. (New York), Vol. 1, No. 3, 222-4 (May-June, 1960).

It is pointed out that Carathéodory's proof of his theorem on pfaffian forms, which was used in his axiomatic development of thermostatics, is not complete and does not make clear whether thi result is valid locally of globally. This theorem is replaced by a more precise statement of a local nature, for which a proof is give By tracing through Carathéodory's use of the concept of thermal equilbrium with respect to simple systems, it is shown how the existence of a global entropy and absolute temperature may be deduced from this local result.

536.7 : 530.1

IRREVERSIBLE COOPERATIVE PHENOMENA. See Abstr. 12369

536.7 : 536.4

THERMODYNAMIC TREATMENT OF DILUTE SUPERCONDUCTING ALLOYS. See Abstr. 12556

LOW-TEMPERATURE PHYSICS

536.48 : 539.1.0

12540 CLOSED CIRCUIT LIQUID HYDROGEN REFRIGERATI SYSTEM.

D.B.Chelton, J.W.Dean and B.W.Birmingham.

Rev. sci. Instrum., Vol. 31, No. 7, 712-16 (July, 1960).

A liquid hydrogen bubble chamber has been maintained at 27° K with an automatically controlled closed circuit hydrogen refrigeration system of 300 W capacity. The system was used continuously for more than 2000 hr on the 15 in. bubble chamber at the Lawrenc Radiation Laboratory, University of California, Berkeley, Californ The design uses commercially available heat exchanger tubing and controls. Actual performance is compared to predicted performan for design operating conditions. The refrigeration system is suffic ently flexible to be used on other experimental apparatus requiring refrigeration at liquid hydrogen temperatures.

536.4

12541 EFFECT OF THE λ TRANSITION ON THE ATOMIC DISTRIBUTION IN LIQUID HELIUM BY NEUTRON DIFFRACTION. D.G.Henshaw.

Phys. Rev., Vol. 119, No. 1, 9-13 (July 1, 1960).

Neutron diffraction patterns for samples of liquid helium at 1.06°, 2.29°, and 2.46° K were measured over the angular range 4° t 64° using 1.06_4 A neutrons. The liquid structure factor i(s) + 1 was deduced for each curve and these show a change associated with the λ-transition, indicating that the spatial order in the liquid is smalle below the λ-point than above. The measurements were transforme to give the radial distribution function $4\pi r^2[\rho(r)-\rho_0]$ from which was deduced the number of neighbours under the first shell of atoms an the nearest distance of approach of two atoms in the liquid. These lie between $8_{.8}$ atoms and $9_{.8}$ atoms and 2.35 A and 2.40 A respectively.

536.4

12542 PRESSURE EFFECT IN THE ATOMIC DISTRIBUTION IN LIQUID HELIUM BY NEUTRON DIFFRACTION.

D.G.Henshaw.

Phys. Rev., Vol. 119, No. 1, 14-21 (July 1, 1960).

The angular distribution of 1.06_4 A neutrons scattered from liquid helium at temperatures and pressures in the range 1.2° to 4.24° K and 0 to 51.3 atm for densities up to 0.184 g/cm^3 was measured at about 210 equally spaced points in the angular range 5° to 6 With increasing liquid density, the principle maximum moves to larger angles and increases in height. The liquid structure factors are given for densities of 0.166 and 0.184 g/cm^3. The density distribution functions are deduced for each of the scattering patterns. A study of these gives 2.27 ± 0.08 A as the nearest distance of approach of two atoms in the liquid. The number of neighbours und first and second coordinate shells changes from about 6.5 to 8.5 ms and from about 9 to 5.5 atoms, respectively, for density nges from 0.095 to 0.184 g/cm^3. The corresponding change in ratio of their spacings is from 1.47$_5$ to 1.38, which values are se to $\sqrt{2}$, the theoretical ratio for a close-packed lattice. The lysis shows that the density changes in the liquid and during the id—liquid transformation cannot be accounted for on the basis of niform dilation of a basic structure. The changes in the distribu- n function caused by pressure are different from those caused by perature along the normal vapour pressure line.

536.48

12543 FLUCTUATIONS OF ATOMIC STRUCTURE IN LIQUID HELIUM. V.K.Prokhorenko and I.Z.Fisher.

. eksper. teor. Fiz., Vol. 36, No. 4, 1311-12 (April, 1959). Russian. English translation in: Soviet Physics—JETP (New York), l. 36(9), No. 4, 928-9 (Oct., 1959).

The fluctuations in the distribution of the number of nearest ghbours of a selected atom in liquid helium has been estimated m the experimental results of Hurst and Henshaw (Abstr. 289 of 56) on the scattering of slow neutrons. Assuming a "Gaussian" tribution, the number of nearest neighbours was derived from a owledge of the fluctuations in, and the average value of, the co- dination number in the liquid. P.A.Walker

536.48

12544 A LATTICE MODEL OF LIQUID HELIUM. III. EQUILIBRIUM PROPERTIES OF LIQUID He^4 AND XTURES OF He^4 AND He^3. H.Matsuda.

ogr. theor. Phys., Vol. 18, No. 4, 357-66 (Oct., 1957).

The partition function of the lattice model of liquid He^4 developed Pt I and II (Abstr. 7063 of 1957; 5845 of 1958) can be derived determining the form of a universal function of one variable, pro- led one admits three assumptions previously made. Instead of termining the function by using Kikuchi's approximation as before, determination is made here by making use of the experimental lues of heat capacity at various temperatures under saturated pour pressure together with two other thermodynamical data at λ-point. Comparison of the values thus derived with experi- ental ones is made for various thermodynamical quantities of pure uid He^4 and of mixtures of He^4 and He^3. The agreements are good, d a consistent explanation of various properties of this liquid is tained. See also following abstract.

536.48

12545 ON THE LATTICE MODEL OF LIQUID HELIUM PROPOSED BY MATSUBARA AND MATSUDA.

Morita.

ogr. theor. Phys., Vol. 18, No. 5, 462-6 (Nov., 1957).

In the lattice model of Matsubara and Matsuda (Abstr. 7063 of 57; 5845 of 1958) the derivation of the Hamiltonian function for lattice gas (substance) is not quite clear; the most important estion is whether the anti-commutativity of annihilation and eation operators of a lattice site does not destroy the Bose pro- rty of the system under consideration. In this note, the miltonian of the lattice gas, which reduces to that of liquid helium en the lattice constant is taken to be infinitesimal, is derived by use of the formalism of second quantization. It is confirmed t the calculations by Matsubara and Matsuda are surely for the se lattice gas (substance) when two particles cannot occupy a tice site at the same time.

536.48

12546 ON THE FORM FACTOR OF LIQUID He^4 AT ABSOLUTE ZERO. I. R.Abe.

ogr. theor. Phys., Vol. 19, No. 1, 57-68 (Jan., 1958).

An integro-differential equation is evolved for the radial dis- bution function in liquid He^4 at absolute zero assuming a particular rm of the ground-state wave-function, the validity of the super- sition approximation and a simple relation between the radial dis- bution function and the wave-function. For a system of hard- heres this equation is transformed into an integral equation for the urier transform of the radial distribution function which is closely lated to the form factor, and an apprixmate solution is obtained der the linear approximation. The calculated form factor is com- red with the experimental data.

536.48

12547 ON THE FORM FACTOR OF LIQUID He^4 AT ABSOLUTE ZERO. II. R.Abe.

Progr. theor. Phys., Vol. 19, No. 4, 407-20 (April, 1958).

A refinement of the approximations made in Pt I (see preceding abstract) is carried out and it is shown that the contradictions concerning the behaviours of the factor S(k) near at k = 0 involved in the previous treatment can be removed. An integral equation for S(k) is solved numerically for the hard-sphere potential and for the modified Lennard-Jones potential. These solutions are compared with the experimental data. Under these approximations, the cohesive energy is shown to be expressed as a function of the sound velocity and S(k), and is calculated using the theoretical and the experimental value of S(k), respectively. The method is applied to a dilute hard-sphere system and the results are compared with those corresponding to an exact one.

536.48

12548 POSSIBLE PHASE TRANSITION IN LIQUID He^3. V.J.Emery and A.M.Sessler.

Phys. Rev., Vol. 119, No. 1, 43-9 (July 1, 1960).

A possible phase transition in liquid He^3 is investigated theoretically by generalizing the Bardeen, Cooper, and Schrieffer equations for the transition temperature in the manner suggested by Cooper, Mills and Sessler (Abstr. 12187 of 1959). The equations are transformed into a form suitable for numerical solution and an expression is given for the transition temperature at which liquid He^3 will change to a highly correlated phase. Following a suggestion of Mottelson, it is shown that the phase transition is a consequence of the interaction of particles in relative D states. The predicted value of the transition temperature depends on the assumed form of the effective single-particle potential and the interaction between He^3 atoms. The most important aspects of the single-particle potential are related to the thermodynamic properties of the liquid just above the transition temperature. Two choices of the two-particle interaction, consistent with experiments, yield a second-order transition at a temperature between $\sim 0.05^\circ$ and 0.1°K. The highly correlated phase should exhibit enhanced fluidity.

536.48

12549 THERMAL CONDUCTIVITY OF ISOTOPIC MIXTURES OF SOLID HELIUM. E.J.Walker and H.A.Fairbank.

Phys. Rev., Vol. 118, No. 4, 913-19 (May 15, 1960).

The thermal conductivity of solid He^4 containing zero, 0.56, 1.38 and 2.8% He^3 was measured as a function of temperature from 1.1° to 2.1°K. For pure He^4, the results are in satisfactory agreement with those of Webb, Wilkinson and Wilks (Abstr. 8836 of 1952). The addition of 1.38% He^3, at a simple density $\rho = 0.208$ g cm^{-3} caused a decrease in thermal conductivity by a factor of 5 at 1.1°K. The additional thermal resistance caused by adding He^3 was substantially independent of temperature, rather than proportional to temperature, as would be expected from isotropically distributed point scatterers. Agreement with Klemens' theory in magnitude and temperature dependence can be obtained by assuming the He^3 to be arranged on lines in the solid. Possible mechanisms to explain these results are discussed.

536.48

12550 DIELECTRIC BREAKDOWN OF LIQUID HELIUM. C.Blank and M.H.Edwards.

Phys. Rev., Vol. 119, No. 1, 50-2 (July 1, 1960).

The dielectric strength of liquid He^4 under its saturated vapour pressure was determined from 1.2 to 4.2°K. With $\frac{3}{8}$ in. diameter spherical steel electrodes 0.15 mm apart the average breakdown field, $\bar{E}_b$, is $\sim$ 1 MV/cm, nearly independent of temperature. At spacings of 0.5 and 1 mm, $\bar{E}_b$, is lower, and appears to decrease with decreasing temperature below 2.5°K. The mechanism of breakdown is not clear, but field emission of electrons from the cathode is probably involved, because the average breakdown voltage $\bar{V}_b$, obtained with a point and plane electrode system when the point is negative, is about half that obtained when the point is positive, both above and below the λ-point. Pre-breakdown currents were never detected, and were probably less than 10^{-13} A, implying an electrical resistivity for liquid helium of 10^{18} ohm cm.

536.48

12551 DAMPING OF THE OSCILLATIONS OF A CYLINDER [IMMERSED] IN ROTATING LIQUID HELIUM II.

Yu.G.Mamaladze and S.G.Matinyan.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 656-7 (Feb., 1960).
In Russian.

The damping of an oscillating disk in rotating helium is significantly influenced by the Onsager—Feynman vortices which are deflected near any solid surface perpendicular to the vortex lines; as a consequence, a maximum had been derived for the damping in dependence of the angular velocity. As a rotating cylinder (neglecting end effects) does not offer any part of its surface to this damping action of the vortices it is expected and verified by calculation that the damping can be fully accounted for by the viscosity of the normal component and the mutual friction between the normal and superfluid component. Damping depends now linearly upon the angular velocity and there is no maximum of damping. R.Eisenschitz

536.48

12552 MEASUREMENT OF THE LOGARITHMIC DECREMENT OF THE DAMPING OF A [OSCILLATING] CYLINDER [IMMERSED] IN ROTATING HELIUM II.

D.S.Tsakadze and I.M.Chkheidze.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 637-8 (Feb., 1960).
In Russian.

The theoretical arguments of Mamaladze and Matinyan (see preceding abstract) are put to an experimental test. The apparatus is calibrated with water; it is found that the damping of oscillations is in quantitative agreement with the results of classical hydrodynamical theory. Measurements with helium at rest are also in agreement with theory, whereby the coefficient of viscosity is taken from oscillating disk experiments. Experiments with rotating helium were made at temperatures of 1.75, 1.60 and 1.48°K. It is found that - in accordance with the theory - the decrement depends linearly on the angular velocity; the effect of the velocity is proportional to the coefficient of mutual friction as determined by Hall and Vinen. R.Eisenschitz

536.48

12553 SECOND SOUND IN HELIUM II.

V.P.Peshkov.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 799-805 (March, 1960). In Russian.

Second sound in helium was investigated by the resonance method at temperatures down to 0.38°K. Attenuation of second sound is so large at temperatures below 0.5°K that no resonances were observed and second sound changed into highly damped thermal waves. The experimental values of u_2 from the λ-point down to 0.55°K (1958 temperature scale) are presented. It is shown that the calculated values of u_2 obtained by Bendt et al. (Abstr. 6047 of 1959) on the basis of cold neutron scattering in helium are in good agreement with straightforward second-sound velocity measurements.

536.48 : 539.2 : 538.27

12554 NUCLEAR SPIN RELAXATION IN SOLID He^3.

J.M.Goodkind and W.M.Fairbank.
Phys. Rev. Letters, Vol. 4, No. 9, 458-60 (May 1, 1960).

Transverse and longitudinal relaxation times were measured as a function of volume and temperature. The temperature dependence indicated that the relaxation was due to self-diffusion between 2.4° and 1.4°K, but below 1°K the relaxation was much too fast to be explained by classical diffusive motion. Discontinuities at the $\alpha-\beta$ phase boundary (Abstr. 228 of 1960) above 2°K were attributed to a change in the diffusion rate. E.F.W.Seymour

536.48 : 530.16

MOMENT OF INERTIA OF SUPERFLUID MANY-FERMION SYSTEMS. See Abstr. 12375

536.48 : 530.16

TRANSPORT PROPERTIES OF LIQUID He. PHONON CONCEPT. See Abstr. 12379

536.48 : 530.16

ROTON SPECTRUM OF LIQUID He^4. See Abstr. 12380-82

536.48

12555 GAUGE INVARIANT FORMULATION OF THE BARDEEN—COOPER—SCHRIEFFER THEORY OF SUPERCONDUCTIVITY.

T.A.Oliphant and W.Tobocman.
Phys. Rev., Vol. 119, No. 2, 502-3 (July 15, 1960).

(See Abstr. 1708 of 1958). The method used is to pair electrons having equal and opposite angular momentum rather than equal and opposite linear momentum.

536.48 : 536

12556 A THERMODYNAMIC TREATMENT OF DILUTE SUPERCONDUCTING ALLOYS.

R.E.Jones, Jr.
I.B.M. J. Res. Developm., Vol. 4, No. 1, 23-7 (Jan., 1960).

The effect of adding small concentrations of an impurity to a superconducting metal is analysed by thermodynamic methods. Tw possible types of variation of the Gibbs free energy with compositi are then discussed, utilizing a number of simplifying assumptions. For the case in which alloys have a superconducting second-order transition, there is a long-range interaction among solute atoms, even in limits of high dilution.

536.4

12557 FURTHER EXPERIMENTS CONCERNING THE SPIN-ELECTRON INTERACTIONS IN SUPERCONDUCTORS.

B.T.Matthias, H.Suhl and E.Corenzwit.
J. Phys. Chem. Solids, Vol. 13, No. 1-2, 156-9 (May, 1960).

The lowering of the superconducting transition temperature of lanthanum by dissolving in it the rare earths Ce, Nd, Sm, Eu, Tb, Ho and Er is reported. The discrepancies regarding previous theoretical considerations are pointed out.

536.4

12558 INTERACTION BETWEEN ELECTRONS AND LATTIC VIBRATIONS IN A SUPERCONDUCTOR.

G.M.Eliashb
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 966-76 (March, 1960). In Russian.

A perturbation theory for the Green's function is developed in which the Green's function calculated for the superconducting grou state is used as the zero approximation. Dyson equations are written down from which the electron Green's function can be determined. Interaction between electrons and phonons is not assumed to be small. The spectrum and damping of the excitations are calculated.

536.4

12559 IRREVERSIBILITY IN THE SUPERCONDUCTING TRANSITION OF LEAD.

R.W.Shaw and D.E.Mapother.
Phys. Rev., Vol. 118, No. 6, 1474-84 (June 15, 1960).

Reports a detailed study of the nature and origins of the hysteresis in the magnetic transition of pure superconducting lead. The effect can be introduced in nonhysteretic specimens by plastic deformation at liquid helium temperatures. The hysteresis becom apparent somewhat below T_c and its width increases monotonically with decreasing temperature. Similar effects can be caused by dilute additions of Ca to Pb. Strain induced hysteresis anneals out near 300°K but temperatures approaching the melting point appear necessary to remove impurity induced effects. Isothermal resisti measurements show a small fraction of the superconducting phase persisting to fields several hundred gauss above H_c. The residual superconductivity at high fields is increased by plastic deformatio and in general seems closely related to the hysteresis effect. The observations suggest the existence of a connected network which pervades the entire specimen volume and consists of very small filaments having a critical field exceeding the reversible critical field of bulk lead. The filaments are believed to be associated with defects in the crystalline lattice.

536.4

12560 THE INFLUENCE OF EXCHANGE INTERACTION ON THE TRANSITION TEMPERATURE OF SUPERCONDUCTORS.

S.V.Vonsovskii and M.S.Svirskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1494-6 (Nov., 1959).
In Russian.

The energy of interaction between electrons which determines the onset of superconductivity is analysed in terms of a Coulomb interaction, an interaction transmitted by phonons and the exchange energy between s- and f-electrons. Numerical values of these ener gies are given for La. Using these data and a formula for the transition temperature, calculations are made for a number of alloys c sisting of La with 1% (atomic) of a rare earth metal. The different atoms are distinct by the difference of spin of the f-electrons. Agreement of calculated and experimental transition temperatures fair. [English translation: Soviet Physics—JETP (New York), Vol 37 (10), No.5, 1060 (May, 1960)]. R.Eisenschi

536.4

12561 THE CRITICAL MAGNETIC FIELD OF RHENIUM DOW TO 0.3°K.

M.Renard.
Physica, Vol. 24, Supplement, S154 (Sept., 1958). In French.
Low Temperature Physics Conference (Abstr. 7017 of 1960).

orts $T_c = 1.698^\circ K$, $H_0 = 198 \pm 2$ G. The $H_c(T)$ curve deviates
n parabolic form by up to 10 G. From the form of the curve at
temperatures, $\gamma = 2.35 \pm 0.2 \times 10^{-3}$ J mole^{-1} deg^{-2}.

R.G.Chambers

536.48

2562 THE CRITICAL CURRENTS IN SUPERCONDUCTING FILMS OF TIN. N.E.Alekseevskii and M.N.Mikheeva.

eksper. teor. Fiz., Vol. 38, No. 1, 292-3 (Jan., 1960).
ussian.

The temperature dependence of the critical current was
estigated near the critical temperature. The experimental
ies for the magnetic field associated with this current are
npared with theory.

K.N.R.Taylor

536.48

2563 THE DESTRUCTION OF SUPERCONDUCTIVITY BY [THE CRITICAL] CURRENT. E.Troinar.

eksper. teor. Fiz., Vol. 38, No. 2, 654-5 (Feb., 1960).
ussian.

Measurements are made of the "critical" resistance of super-
ductors, i.e. the resistance found when the current passes through
critical value. Experiments are made with a number of samples
in wire differing by their dimensions and their purity. Experi-
ntal results are shown in graphs. The ratio of the critical to the
mal resistance is found to be of the order 0.5 to 1, which is in
ordance with previous experience and theoretical estimates. This
o is plotted against the density of heat flow in the wires; by col-
ing the points which are obtained from different samples at the
ie temperature, smooth graphs are obtained.

R.Eisenschitz

536.48 : 621.374.32

12564 THERMAL PROPAGATION OF A NORMAL REGION IN A THIN SUPERCONDUCTING FILM AND ITS APPLICA-
N TO A NEW TYPE OF BISTABLE ELEMENT.

.Broom and E.H.Rhoderick.
t. J. appl. Phys., Vol. 11, No. 7, 292-6 (July, 1960).

For earlier work see Abstr. 1082 of 1960. The movement of
interphase boundary due to Joule heating in a partially super-
ducting film carrying a current is analysed. It is shown that there
value of the current at which the boundary remains stationary;
ve this value the normal region grows, and below it, the normal
ion collapses. As the current approaches the critical current of
film, the speed of propagation becomes very large and of the
it order to explain the authors' previous observations on the rate
eturn of resistance to thin superconducting strips driven into the
mal state by rectangular current pulses. The current required to
ntain the boundary stationary is much less than that necessary to
erate a normal region initially. This enables a new type of
able element to be constructed, consisting of a strip of super-
ducting film carrying a continuous current equal to that necessary
naintain the boundary stationary. A short pulse of current in the
ie sense as the standing current generates a normal region in the
which is subsequently held constant by the standing current,
le a short pulse in the opposite sense cancels the standing current
; enough for the film to become completely superconducting again.
s device is extremely simple in construction and can be switched
n one state to the other in 10 mμs.

536.48 : 530.16

QUASICHEMICAL EQUILIBRIUM APPROACH TO SUPER-
NDUCTIVITY. See Abstr. 12383

536.48 : 539.2 : 538.2

MAGNETIC PROPERTIES OF FERROMAGNETIC SUPERCON-
CTORS. See Abstr. 11844

ELECTRICITY
ELECTRICAL MEASUREMENTS

537

2565 IRREVERSIBLE THERMODYNAMICS OF A NON-LINEAR R–C SYSTEM. W.Bernard and H.B.Callen.

s. Rev., Vol. 118, No. 6, 1466-70 (June 15, 1960).

The formalism of nonlinear irreversible thermodynamics, as recently developed (Abstr. 902 of 1960), is applied to a circuit containing a capacitor and a nonlinear resistor. The solution is compared with those obtained by Lax and other investigators. It is shown that the fluctuation-dissipation theorem is rigorous, and that no correction factors need be introduced for nonlinear systems. The dynamical behaviour of the microscopic fluctuations, from which the macroscopic motion can be obtained, is also derived. Finally, a specific Markoffian model of a nonlinear R–C system, in strong interaction with a temperature reservoir, is shown to be consistent with the general analysis.

537.7 : 537.533 : 621.385.032.213.13 : 621.317.332.1

12566 A NEW METHOD FOR THE MEASUREMENT OF CATHODE INTERFACE IMPEDANCE. J.Tamiya.

Rev. sci. Instrum., Vol. 31, No. 7, 696-700 (July, 1960).

A simple and sensitive bridge method for the measurement of cathode interface impedance is reported. A tube with an interface impedance under test in this method forms a bridge together with a reference tube with no interface layer and with an external variable RC circuit in its cathode return. The bridge is excited by a set of three sinusoidal signals of 200 kc/s, 1.1 and 5 Mc/s. The unknown interface impedance is then measured by simultaneously balancing the bridge for these frequencies. The detector consists of amplifiers tuned to each frequency and a c.r.o. that displays each signal separately. A small wobbling of the transconductance in the reference tube is also provided for simplifying the measurement and overcoming drift of tube characteristics. This bridge has a sensitivity of the order of 0.002 rad as a minimum detectable phase-shift, and allows a measurement of interface resistances as low as a few ohms with time constants of 0.01 μsec or more, even in ordinary tubes.

537.7 : 621.317.7

12567 WIDE-BAND DETECTOR FOR MICRO-MICROAMPERE LOW-ENERGY ELECTRON CURRENTS.

T.E.Everhart and R.F.M.Thornley.
J. sci. Instrum., Vol. 37, No. 7, 246-8 (July, 1960).

Electrons with a mean energy of a few electron volts emerging from a source a few millimetres in diameter are accelerated on to a positively biased plastic scintillator. The light generated in the scintillator is guided by a Perspex light-pipe to a photomultiplier. If the scintillator bias is greater than 10kV, no noise is introduced by the scintillator–light-pipe–photomultiplier system. If the original electron signal is modulated, the maximum modulation frequency transmitted by the system is greater than 10 Mc/s. The minimum detectable current is limited by the photomultiplier dark current, and may be less than 10^{-15} A with a suitably chosen tube.

537.7 : 621.317.733

12568 IMPROVED SQUARE WAVE INDUCTANCE BRIDGE. B.Howland.

Rev. sci. Instrum., Vol. 31, No. 7, 763-8 (July, 1960).

An a.c. bridge, useful for comparing an inductance coil with its dual equivalent circuit so as to determine, with one square wave null measurement, the values of the inductance, the equivalent series and shunt resistances, and the distributed capacitance, is described. This circuit, which features a wideband transformer of novel but simple construction, has the important advantage that one terminal of both the inductor and its dual circuit are at ground potential. Shielding problems are thereby minimized, and laboratory type decade boxes and precision variable condensers may be used to synthesize the dual equivalent circuit or to adjust the distributed capacitance of the inductor. A prototype bridge circuit, operating in the frequency range 0.1 to 350 kc/s, and incorporating compensation for errors due to residual elements is given, together with a simple alignment procedure and the results of a sample measurement of a standard inductor. It is shown that the frequency limitations of the present bridge circuit are not fundamental; an improved high frequency compensation scheme using the concept of the distributed transformer should permit operation in the v.h.f. range. The resulting transmission line bridge circuit may also have application as a precision wide band pulse reflectometer.

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

537.2

12569 INVESTIGATION OF FINITE DIFFERENCE EQUATIONS FOR POINTS SITUATED ON A SURFACE DISTRIBUTION OF CHARGES. THE CASE OF SYSTEMS OF REVOLUTION.
J.Gelard.
C.R. Acad. Sci. (Paris), Vol. 250, No. 21, 3455-7 (May 23, 1960).
In French.

The points form a 3 × 3 square lattice. Cases of surfaces where the meridians are respectively perpendicular and parallel to the axis of rotation are given. G.A.Chisnall

CURRENT ELECTRICITY
ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

537.3

12570 CONTRIBUTION TO THE THEORY OF ELECTRON GAS CONDUCTIVITY IN A STRONG MAGNETIC FIELD.
V.G.Skobov.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1304-11 (April, 1960).
In Russian.

The conductivity of an electron gas in perpendicular electric and magnetic fields is investigated for $\omega\tau \gg 1$ (τ is the electron relaxation time, ω is the cyclotron frequency). Elastic scattering of electrons on fixed short-range force centres is considered. Interaction between electrons and the scatterers is treated without the aid of perturbation theory. In the final result the conductivity is expressed as a function of the magnetic field and of the exact amplitude for scattering of a zero-energy electron on a single centre in the absence of a magnetic field.

537.3 : 621.319.53

12571 NEW HIGH-VOLTAGE MULTI-STAGE IMPULSE GENERATOR CIRCUIT. T.E.Broadbent.
J. sci. Instrum., Vol. 37, No. 7, 231-6 (July, 1960).

A new high-voltage multi-stage impulse generator circuit is described. The circuit is based on conventional multi-stage impulse generator circuits but trigatrons are used in each stage in place of the sphere gaps used in conventional circuits. The triggering pulse necessary to fire each trigatron is derived from the breakdown of the previous stage. For all multi-stage impulse generators of this type (other than very small ones), the stray capacitance coupling between stages is sufficient to operate the trigatrons, and no extra coupling capacitance is required. With the new circuit, multi-stage generators operate over a much greater range of voltage for given gap spacings in the various stages than is the case with the conventional circuits. The need for the spark gaps in each stage to be critically set is thereby eliminated. The results of an experimental comparison between the new and conventional circuits are described.

537.3 : 621.372.54

12572 LOW FREQUENCY WAVE FILTERS EMPLOYING THERMISTORS. R.A.Rasmussen.
Rev. sci. Instrum., Vol. 31, No. 7, 747-51 (July, 1960).

A review of the general properties of thermistors and analyses of their small signal characteristics are presented. Measurements of their a.c. properties and response curves obtained for the simplest filter circuit configurations are then described and the results analysed.

537.3 : 621.382

12573 OHMIC CONTACTS TO SEMICONDUCTING CERAMICS. D.R.Turner and H.A.Sauer.
J. Electrochem. Soc., Vol. 107, No. 3, 250-1 (March, 1960).

Describes a method of preparing stable low-resistance ohmic contacts to titanate ceramics to which terminals can be soldered. The process can be used to make ohmic contacts to intermetallic compounds such as gallium arsenide and thermoelectric semiconductors such as bismuth telluride. The method consists of depositing metal contacts such as nickel on appropriate surfaces of the material and subsequently heat treating the contacts. Nickel is deposited most conveniently by chemical reduction, the "electroless" process.

537.32

12574 ELECTRICAL DETERMINATION OF THE THERMAL PARAMETERS OF SEMICONDUCTING THERMO-ELEMENTS. C.H.Herinckx and A.Monfils.
Brit. J. appl. Phys., Vol. 10, No. 5, 234-6 (May, 1959).

A method of obtaining the thermal conductivity, thermal capacit electrical conductivity and figure of merit of thermoelectric materia from observations of the time dependence of the p.d. across thermal insulated specimens and their mean temperature is described.
G.C.William

537.32

12575 DIAGRAMS REPRESENTING STATES OF OPERATION OF A GENERAL THERMOCOUPLE. A.H.Boerdijk.
J. appl. Phys., Vol. 31, No. 7, 1141-4 (July, 1960).

The state of operation of a thermocouple of which (a) the bars have an arbitrary shape; (b) the properties of the materials are arbitrary functions of temperature; and (c) the composition is, under certain restrictions, inhomogeneous and anisotropic depends on thre independent parameters: the current I and the temperatures T_1, T_2 c the junctions. If T_2 is kept constant, operating characteristics, such as curves of constant output power or efficiency, can be plotted in a I, (T_2-T_1) diagram. The existence of regions of generation of electricity and of cooling is proved. These regions are investigated. Possible generalization and reduction of the diagram are discussed. As an illustrative example, the cooling region of a general couple with temperature independent properties is dealt with.

537.32 : 620.1

12576 METHOD OF BUTT WELDING SMALL THERMOCOUPLES 0.001 TO 0.010 INCH IN DIAMETER.
C.M.Stover.
Rev. sci. Instrum., Vol. 31, No. 6, 605-8 (June, 1960).

A method of butt welding thermocouples 0.001 to 0.010 in. in diameter is described. The thermocouple wires are positioned in a micro-manipulator, and a controlled welding pulse is applied to them. This welding method provides uniform upset welds through a simple production technique.

IONIZATION

537.56

12577 OPTICAL METHODS FOR NEGATIVE ION STUDIES. S.J.Smith and L.M.Branscomb.
Rev. sci. Instrum., Vol. 31, No. 7, 733-47 (July, 1960).

A high vacuum crossed-beam apparatus for the study of photodetachment of electrons from negative ions is described, with emphasis on (1) the optical system which transmits a filtered high intensity photon beam, (2) a high transmission mass selector and associated ion optics, and (3) the sensitive a.c. preamplifier, amplifi and phase sensitive detector used for measuring the photodetached electron current. The methods used for calibrating and operating the apparatus are discussed.

537.56

12578 IONIZATION OF INERT GASES BY MULTICHARGED IONS. N.V.Fedorenko, I.P.Flaks and L.G.Filippenko.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 719-25 (March, 1960).
In Russian.

The total ionization cross-sections (σ_-) were measured for single collisions between Ne^+, Ne^{2+}, Ne^{3+}, Kr^+, Kr^{2+}, Kr^{3+}, Xe^+, Xe^{2+}, Xe^{3+}, Xe^{4+} ions and inert-gas atoms. In the investigated accelerating-voltage range (from 3 to 30 kV) it was found that for equal ion energies the ionization cross-section is practically independent of the charge of the primary ion. For all ion—atom pairs a continuous rise of the cross-section with increasing kinetic energy of the primary ions was observed. In most cases the absolute values of the measured cross-sections were close to those computed by Firsov's formula (Abstr. 9750 of 1960).

537.56

12579 IONIZATION OF GASES BY NEGATIVE IONS.

Ya.M.Fogel' A.G.Koval' and Yu.Z.Levchenko.
h. eksper. teor. Fiz., Vol. 38, No. 4, 1053-60 (April, 1960). In ussian.

Measurements were made of the total effective cross-sections formation of positive ions as a result of collisions of 10 to 50 eV H^- ions with He, Ne, A, Kr and Xe atoms and H_2, N_2 and O_2 olecules and as a result of collisions between O^- ions of the same ergies with inert gas atoms and H_2 and O_2 molecules. The ionizaon cross-sections for H^- and H^+ ions were compared.

537.56 : 537.533

12580 THE IONIZATION AND DISSOCIATION OF MOLECULES BY MONO-ENERGETIC ELECTRONS. I. CONSTRUCTON AND OPERATION OF THE ION SOURCE USED.

J.Collin.
. Chim. phys., Vol. 57, No. 5, 416-23 (May, 1960). In French.

The different ways of obtaining monoenergetic particles for the udy of ionization and dissociation processes in molecules are riefly reviewed and discussed. A monoenergetic ion source of the ox type is presented and its operating conditions discussed in etail, with particular emphasis on its characteristics. It has been sted with rare gases.

537.56 : 539.19

12581 THE IONIZATION AND DISSOCIATION OF MOLECULES BY MONO-ENERGETIC ELECTRONS. II. EXCITED TATES OF THE MOLECULAR ION OF CO_2 AND CS_2.

J.Collin.
. Chim. phys., Vol. 57, No. 5, 424-9 (May, 1960). In French.

The ionization of these two molecules was investigated using nonoenergetic electrons. It was possible to detect different excited tates of the molecular ions. For CO_2, four different states were ound at 13.85, 17.23, 19.25 and 21.00 V. Their identification was artly established by a comparison with u.v. spectroscopic data as ell as with theoretical calculations of the molecular orbitals. For S_2, six states were detected at 10.15, 12.01, 13.60, 14.76, 15.90 nd 18.10 V. A tentative identification is proposed; in particular, bent excited state of CS_2^+ seems to have been identified and atisfactory agreement is found with the known spectroscopic data.

537.56 : 537.534

12582 THE ROLE OF MULTIPLE PROCESSES IN FORMATION OF PROTONS IN ION SOURCES.

M.D.Gabovich.
h. tekh. Fiz., Vol. 30, No. 3, 354-8 (March, 1960). In Russian.

The theory of the formation of protons in multiple processes, nitiated or maintained by electron collisions, is examined. In articular, it is shown that in the plasma of a discharge at low ressure, with a relatively small percentage of ionization, proton ormation will proceed chiefly by the dissociation of molecules into eutral atoms followed by the ionization of the separate atoms. It s shown that in the case of the recombination of atoms of hydrogen on etal surfaces, the corresponding coefficient may be significantly ess than unity and this must be found by analysing the protons formed. he theoretical expectations agree well with experimental results.

J.H.Fremlin

537.56

12583 MASS-SPECTROMETRIC DETECTION OF THE $(NeA)^+$ MOLECULAR ION.

R.Fuchs and W.Kaul.
. Naturforsch., Vol. 15a, No. 2, 108-15 (Feb., 1960). In German

A mass-spectrometric investigation of a mixture of Ne and A stablished the existence of the $(NeA)^+$ molecular ion. The ion is ormed by a two-stage process: (i) excitation of a Ne atom followed y (ii) reaction with an A atom, $Ne' + A \rightarrow (NeA)^+ + e^-$. A value of 6.5 V was obtained for the appearance potential compared with one f 15.1 V for the A_2^+ species. A search for the corresponding $AKr)^+$ molecular ion gave positive results, but no information conerning its mode of formation has yet been deduced.

W.J.Orville-Thomas

537.56

12584 MASS-SPECTROMETRIC INVESTIGATIONS OF ARGON—NITROGEN MIXTURES AND NITROGEN.

.Kaul and R.Fuchs.
. Naturforsch., Vol. 15a, No. 4, 326-35 (April, 1960). In German.

On admitting nitrogen to argon, peaks were obtained corresonding to the mass numbers 54 and 68 when the pressure in the ource exceeded 8.5 × 10^{-5} mm Hg. These peaks were assigned to N^+ and AN_2^+. It is assumed that these molecular ions are formed the reactions $(N_2^+)' + A \rightarrow AN^+ + N$ and $A' + N_2 \rightarrow AN_2' + e^-$, respectively. Formation of N_3^+ is ascribed to the reaction $(N_2^+)' + N_2 \rightarrow N_3^+ + N$. No evidence was found for the existence of N_4^+.

R.Schnurmann

537.56

12585 INFLUENCE OF NEGATIVE IONS ON AMBIPOLAR DIFFUSION OF ELECTRONS.

H.J.Oskam and V.R.Mittlestadt.
J. appl. Phys., Vol. 31, No. 5, 940-1 (May, 1960).

The ambipolar diffusion coefficient, estimated from measurements of frequency shift observed in microwave discharges in Ne + 0.1% A, increased with time. This increase is attributed to the presence of negative ion impurities released from walls.

C.G.Morgan

537.56

12586 IONIC CONDUCTIVITY OF HIGHLY IONIZED PLASMAS.

M.Sakuntala, A. von Engel and R.G.Fowler.
Phys. Rev., Vol. 118, No. 6, 1459-65 (June 15, 1960).

When a cloud of highly ionized gas ejected by a plasma shock tube is made to travel across a constant magnetic field, an electromotive force is produced in the plasma in a direction normal to both the field and the plasma path. Using two probes facing one another, this electromotive force was measured with an oscillograph. Its maximum value was found to be proportional to the field and the probe separation. By taking the maximum probe potential for different values of the external resistance between the probes, the lowest value of the "resistivity of the plasma" as measured by a current entering and leaving it was obtained. The resistivity was shown to be independent of the magnetic field, the collecting area, the separation and surface state of the probes. All experiments were made in hydrogen at a gas pressure between 0.5 and 5 mm.Hg with a nearly critically damped current pulse of order 10^4 A lasting for about 6-8μsec and field <2000 G. The plasma resistivity between the probes was found to be of the order 1 ohm cm at a gas pressure of a few mm of Hg. This is about 100 times larger than the electronic resistivity of a fully ionized gas for currents circulating internally. The degree of ionization is thought to be high enough for interaction between charged particles to predominate. The measured values of the plasma resistivity agree with the results obtained from theory based on ionic conduction in the plasma which is here the necessary prerequisite for maintaining the electric neutrality of the moving plasma. From the measured probe voltage the flow velocity of the plasma was derived. Its variation with gas pressure agrees with shock wave theory.

537.56

12587 CONCERNING THE THEORY OF BIPOLAR CURRENTS IN A GAS.

L.É.Tsȳrlin.
Zh. tekh. Fiz., Vol. 29, No. 6, 763-72 (June, 1959). In Russian.
English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 6, 687-95 (Dec., 1959).

Discusses previously derived equations [Zh. tekh. Fiz., Vol. 23, 10(1953)] relating current flow in a lightly ionized gas to the electrostatic field in the absence of current flow. Compares theory and experiment for the case of flow between two parallel conducting wires.

R.S.Pease

537.56

12588 THE DISTRIBUTION OF IONS FORMED BY ATTACHMENT OF ELECTRONS MOVING IN A STEADY STATE OF MOTION THROUGH A GAS.

C.A.Hurst and L.G.H.Huxley.
Austral. J. Phys., Vol. 13, No. 1, 21-6 (March, 1960).

The distribution of ions formed by attachment of electrons diffusing through a gas is solved exactly, and the results compared with an approximate calculation given earlier by Huxley. The corrections to the approximate results are inside the present experimental error, and so confirm the satisfactory agreement with experiment already obtained.

537.56

12589 ON THE MAXIMUM NON-RESONANCE CHARGE-TRANSFER CROSS-SECTION.

N.V.Fedorenko and V.A.Belyaev.
Zh. eksper. teor. Fiz., Vol. 37, No. 6(12), 1808-10 (Dec., 1959). In Russian.

A brief review of the relevant literature is given in an investigation of the dependence of σ_{max} on the energy defect for H^+, He^+ and C^+ in inert gases.

S.Chomet

537.56 : 537.534

12590 SCATTERING OF MULTIPLY-CHARGED IONS, LINKED WITH ELECTRON CAPTURE.

N.V.Fedorenko, L.G.Filippenko and I.P.Flax.

Zh. tekh. Fiz., Vol. 30, No. 1, 49-56 (Jan., 1960). In Russian.

The scattering of fast neon and krypton ions in neon and krypton gases is investigated. It is found that electron capture is linked with small-angle scattering, complete neutralization of the ions taking place over a smaller angular range than either partial neutralization or scattering without change of charge. From the results, the distance within which nuclei must approach one another in order to engender electron capture is calculated.

A.E.I. Research Laboratory.

537.56

12591 THE THEORY OF VOLUME RECOMBINATION OF IONS.

G.L.Natanson.

Zh. tekh. Fiz., Vol. 29, No. 11, 1373-80 (Nov., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 11, 1263-9 (May, 1960).

A very detailed analysis of the theory of ion—ion recombination. The earlier Thomson theory is considered and developed comprehensively. Calculated recombination coefficients agree closely with the experimental data of Sayers and Mächler. J.D.Craggs

ELECTRIC DISCHARGES

537.52

12592 COHERENCE AND BAND-WIDTH OF A GAS DISCHARGE HARMONIC GENERATOR.

N.R.Bierrum, D.Walsh and J.C.Vokes.

Nature (London), Vol. 186, 626 (May 21, 1960).

Harmonics are generated when a gas discharge occurs in a microwave field. By beating together fourth harmonics from two gas discharges activated by 3 cm power it is shown that they are coherent. A further experiment indicates that the bandwidth of the harmonic signal is less than 1 Mc/s. D.Walsh

537.52

12593 DETERMINATION OF THE GAS DENSITY AND THE ELECTRON CONCENTRATION IN A DISCHARGE USING AN INTERFEROMETRIC METHOD.

A.M.Shukhtin.

Optika i Spektrosk., Vol. 7, No. 6, 838-9 (Dec., 1959). In Russian.

Variations of the gas density and the electron concentration at the axis of a straight discharge tube (100 cm long, 6 cm diameter), filled with argon and excited with square pulses of ~200 μsec duration and 600 A amplitude, were deduced from changes of the refractive index, measured with a double-beam Rozhdestvenskii interferometer crossed with a quartz spectrograph. The discharge tube was illuminated with a source emitting a continuous spectrum. Almost complete absence of gas at the axis of the discharge tube, filled with argon at 6 mm Hg, was found at a certain stage of the discharge. A.Tybulewicz

537.52

12594 STUDIES WITH A HIGH-FREQUENCY [DISCHARGE] APPARATUS EQUIPPED WITH A STATIC MAGNETIC FIELD.

H.Schlüter.

Z.Naturforsch., Vol. 15a, No. 3, 281-4 (March, 1960). In German.

A powerful electrodeless discharge, at 3 - 30 Mc/s, is applied to hydrogen of high purity under carefully controlled pressures. Wall-effects are minimized by application of a variable static magnetic field. In plasma of low density, much improved studies of atomic spectra are possible. The ohmic resistance of the discharge passes through a minimum at a certain value of the static magnetic field. Under otherwise constant conditions, the corresponding frequencies of gyration of ion—electron systems are found to be approximately proportional to the square-roots of both the exciting frequency and of the gas-pressure, in accordance with theory (Abstr. 361 of 1959; 10928 of 1960). The effects of replacing hydrogen by deuterium are also in agreement with expectation.

J.Sheridan

537.52

12595 THE TEMPORAL DEVELOPMENT OF A TOWNSEND DISCHARGE.

H.Schlumbohm.

Z.Phys., Vol. 159, No. 2, 212-22 (1960). In German.

Oscillographic studies of the current of a Townsend discharge — started by 10^3 to 10^5 electrons within some mμsec — demonstra the development of the discharge in separated generations of electro Experiments were made in N_2, CH_4, CO_2 and in mixtures of N_2 and CH_4, and of A and air (gap-length 1.8 to 3 cm, pressure 50 to 400 mm Hg). A careful curve-fitting with calculated currents shows the agreement between the measured and calculated curves. This corre pondence shows that the discharge is governed by (a) the ionization b collisions and (b) a secondary-photo-effect at the cathode.

537.52

12596 VELOCITY OF STRIATIONS IN INERT GASES.

A.V.Nedospasov.

Zh. tekh. Fiz. Vol. 29, No. 11, 1388-9 (Nov., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 11, 1278-9 (May, 1960).

A brief note giving a phenomenological theory of striations. No comparison with experimental data is given. J.D.Cragg

537.52

12597 CONCERNING V.I.TVERDOKHLEBOV'S ARTICLE "CONNECTION BETWEEN LANGMUIR PROBE-CHARACTERISTIC METHOD AND THE METHOD OF TWO PROBES IN DETERMINATION OF ELECTRON TEMPERATURE".

S.D.Vagner.

Zh. tekh. Fiz., Vol. 28, No. 12, 2739-40 (Dec., 1958). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 3, No. 12, 2507-8 (Dec., 1958).

See Abstr. 4044 of 1958. Modifications to two equations are proposed taking into account the potential difference existing betwee probes when the current in the probe circuit is zero. Neglect of the change in ionic current in the probe serving as anode when U → 0 but not for the case of the probe serving as cathode is also disputed

W.G.Townsen

537.52

12598 ANSWER TO S.D.VAGNER.

V.I.Tverdokhlebov.

Zh. tekh. Fiz., Vol. 28, No. 12, 2740-1 (Dec., 1958). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 3, No. 12, 2509 (Dec., 1958).

See preceding abstract. The first correction is accepted and the equations modified accordingly. The second point of dispute is unfounded and the approximation is valid. W.G.Townsen

537.52 : 539.1

HELIUM LEVEL POPULATIONS IN A GLOW DISCHARGE.

See Abstr. 9767

537.5

12599 THE DYNAMIC PROPERTIES OF HIGH PRESSURE XENON ARCS.

H.J.Hentschel.

Z. angew. Phys., Vol. 12, No. 5, 223-30 (May, 1960). In German.

Experiments were carried out with electrical and optical modu lation, and the general effects on the arc properties are discussed analytically. Modulation frequencies varied from 100 c/s to 25 kc/s. J.D.Cragg

537.52 : 532.

INFLUENCE OF ELECTRODE SURFACE CONDITIONS ON TH ELECTRICAL STRENGTH OF LIQUIFIED GASES.

See Abstr. 124

537.52 : 532

ELECTRICAL STRENGTH OF LIQUID HYDROCARBONS.

See Abstr. 12424

537.52 : 532.

BREAKDOWN OF LIQUID HYDROCARBONS.

See Abstr. 1242

537.52 : 621.319.

12600 DESIGN AND PERFORMANCE OF A COMPACT SURG GENERATOR.

E.Thornton.

Brit. J. appl. Phys., Vol. 11, No. 7, 265-8 (July, 1960).

A compact surge generator for investigation of a fast, linear, pinched discharge using only moderate energy storage is described The technique of construction using an explosive switch to obtain low inductance, and the method of measuring current are discussed The behaviour of the surge generator when short circuited is deter mined from the current waveform, and inductance and resistance values are deduced. The inductance and resistance of the switch are much less than those for the whole circuit, with a linear discharge in deuterium.

537.52 : 621.387

12601 A STUDY, WITH EXPERIMENTAL TESTS, OF A HOT-CATHODE GAS-FILLED DIODE FOR H.F. INTERRUP-
ION. J.Godart.
.R. Acad. Sci. (Paris), Vol. 250, No. 20, 3299-301 (May 16, 1960).
n French.

A brief note on a hot-cathode diode for the replacement of T.R. witches. Graphical data on insertion losses, band-width, etc., are resented. J.Craggs

PLASMA

537.56

12602 HEATING OF AN IONIZED GAS SHEATH BY MICROWAVES. M.S.Sodha.
ppl. sci. Res. B., Vol. 8, No. 3, 208-12 (1960).

An isothermal rigid uniform sheath is discussed assuming at the temperature of the sheath rises due to the absorption of icrowaves, which in turn increases the electron density and there-y affects the absorption. This process continues until the absorbed icrowave energy equals the energy lost by radiation.

537.56

12603 STATISTICAL MECHANICS OF PLASMA OF SEVERAL COMPONENTS. P.Cavailles, R.Jancel and T.Kahan.
.R. Acad. Sci. (Paris), Vol. 250, No. 20, 3282-4 (May 16, 1960).
n French.

A preliminary note. The macroscopic equations of motion of a lasma containing charged and neutral components are derived from oltzmann's equation. The results are applied to binary and ternary lasmas. H.N.V.Temperley

537.56

12604 STATISTICAL MECHANICS OF PLASMAS: APPLICATIONS OF THE BOLTZMANN AND FOKKER—PLANCK QUATIONS. R.Jancel and T.Kahan.
ahiers de Phys., Vol. 13, No. 107-8, 289-308 (July-Aug., 1959).
n French.

This review article deals with both fully ionized and weakly nized gases under conditions when hydrodynamic concepts apply. he topics treated are: important orders of magnitude; statement f Boltzmann's equation; derivation of macroscopic transport quations; several methods for approximately solving Boltzmann's quation; derivation and validity of the Fokker—Planck equation; ethods based on the N-particle Liouville equation. O.Penrose

537.56

12605 THE COLLISIONS OF TWO PLASMA STREAMS. A.Hruška.
zech. J. Phys., Vol. 10, No. 1, 33-9 (1960).

The mutual interaction of two colliding plasma streams is nvestigated by means of the perturbation method. The disordered andom motions of electrons are taken into account. It is shown hat electron oscillations occur only when certain conditions as to he density and relative velocity of the colliding streams are ful-lled. The order of magnitude of the thickness of the shock generated y the initial relative motion is estimated on various assumptions.

537.56

12606 THE PLASMA JET IN HIGH TEMPERATURE RESEARCH. S.Katz, E.J.Latos and E.Raisen.
ndustr. engng Chem., Vol. 52, No. 4, 289-90 (April, 1960).

Since the early work of Gerdien many variations of fluid-tabilized arcs have been reported. Currently made plasma jets ave great versatility, as the boundaries of each property have been xtended by appropriate changes in design. The limits of variation re: temperature from 8000 to 50 000° C; power from 500 W to 3 MW; rifice diam. from 0.04 to 3 in; plasma velocity subsonic to Mach 20; he thermal flux being up to 40 kcal cm^{-2}min^{-1}. The plasma jet akes possible many vapour-phase processes. Crystals of efractory materials can be grown from the vapour phase. Flame praying is being developed. Other possible applications are apour-phase separation of ores and production of alloys, welding in e conventional manner, and special welding to form refractory aterials. R.Schnurmann

537.56

12607 MICROWAVE CONDUCTIVITY OF A PLASMA IN A MAGNETIC FIELD. D.C.Kelly.
Phys. Rev., Vol. 119, No. 1, 27-39 (July 1, 1960).

The Boltzmann equation for electrons in a uniform isothermal plasma is solved by expressing the distribution function as a series of orthogonal polynomials in velocity space with time dependent expansion coefficients. The microwave conductivity is simply related to certain coefficients. Particular attention is devoted to the case in which the plasma is subject to a constant magnetic field and a microwave electric field. By introducing an "effective" electron temperature, convergence is attained for strong as well as weak electric fields. The formulation is particularly suited for problems involving partially ionized gases which contain several species of ions and neutrals. The conductivity of a completely ionized gas is calculated with and without consideration of electron—electron collisions, and the ratio (γE) of the two results is illustrated graphically as a function of microwave frequency.

537.56

12608 EFFECT OF ELECTRON EXCHANGE ON THE DISPERSION RELATION OF PLASMA OSCILLATIONS.
H.Kanazawa and S.Tani.
Progr. theor. Phys., Vol. 19, No. 2, 153-8 (Feb., 1958).

The dispersion relation is derived by adopting a canonical transformation which is a little different from that of Bohm and Pines (Abstr. 1278 of 1954). The result shows that electron exchange gives a small contribution to the Bohm—Pines dispersion relation. This result is compared with that given by Ferrell (Abstr. 1838 of 1958) using the Hartree—Fock self-consistent method, referring to the experimental data.

537.56

12609 PARTITION OF ENERGY IN A PULSED PLASMA ACCELERATOR. W.J.Guman.
Phys. of Fluids, Vol. 3, No. 3, 483-4 (May-June, 1960).

Shows that in a plasma behind a magnetically driven strong shock the kinetic energy exceeds the thermal energy if the shock overtakes a uniformly moving fluid. In the non-steady state flow through a constant area duct, further conversion of thermal to kinetic energy is achieved if the strong shock collides head on with a complete rarefaction wave. C.G.Morgan

537.56

12610 COMMENTS ON "CONFINEMENT OF PLASMA BY STANDING ELECTROMAGNETIC WAVE". S.A.Self.
Phys. of Fluids, Vol. 3, No. 3, 488-9 (May-June, 1960).

Cushing and Sodha's paper (Abstr. 13397 of 1959) is criticized mainly on the grounds that it assumes the field in the confined plasma to be periodic and have zeros. It is shown that solutions of the problem exist for which this is not true. D.Walsh

537.56

12611 A FUNDAMENTAL ERROR IN THERMONUCLEAR RESEARCH. J.Slepian.
Phys. of Fluids, Vol. 3, No. 3, 490-1 (May-June, 1960).

The correct steady state condition for motion in a plasma is that the partial derivative of velocity with respect to time is zero. Many stability calculations for plasma experiments equate the total derivative to zero. It is suggested that the term thus neglected might explain the low containment actually achieved in stellerator and mirror machines. D.Walsh

537.56

12612 VIRIAL THEOREM FOR PLASMAS. G.Schmidt.
Phys. of Fluids, Vol. 3, No. 3, 481-2 (May-June, 1960).

Derives a virial theorem for plasmas by a generalization of the Chandrasekhar—Fermi theorem. (Abstr. 37 of 1954). C.G.Morgan

537.56

12613 CYCLOTRON ABSORPTION OF ELECTROMAGNETIC WAVES IN A PLASMA. K.N.Stepanov.
Zh. eksper. teor. Fiz., Vol. 38, No. 1, 265-7 (Jan., 1960).
In Russian.

Some formulae are given for the complex refractive index of a plasma in a magnetic field when the frequency of the waves is a multiple of the electron or ion gyrofrequency. These formulae appear to be based on the theory of Sitenko and Stepanov (Abstr. 3465 of 1957). O.Penrose

537.56

12614 RELATIVISTIC KINETIC EQUATION FOR A PLASMA. II.

Yu.L.Klimontovich.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1212-21 (April, 1960). In Russian.

For Pt I, see Abstr. 9031 of 1960. The system of equations describing relativistic distribution functions obtained in Pt I, is used to deduce a second-approximation relativistic kinetic equation for a plasma. A kinetic equation in which only the retarding interaction of charged particles is taken into account is derived first. In one special case this equation is identical with that derived by Belyaev and Budker (Abstr. 6398 of 1956). The Fokker—Planck relativistic equation is considered for a plasma with the retarding interaction and with excitation of plasma oscillations by nonequilibrium charged particles.

537.56 : 621.384

12615 A COMPARISON OF ION AND PLASMA PROPULSION.

S.W.Kash.

Proc. Inst. Radio Engrs, Vol. 48, No. 4, 458-65 (April, 1960).

Several important features and parameters of ion and plasma accelerators for propulsion are compared. Estimates for the thrust of individual ion and plasma acceleration units are given. Impulse measurements for a collinear electrode plasma accelerator are presented. The maximum thrust for an ion gun does not depend on the diameter of the beam, but primarily on the accelerating voltage. Because of the relatively small thrust of the ion accelerator, a greater number of them will be required for a given total amount of thrust. Estimates indicate that the ion accelerator may be somewhat more efficient; however, further experiments are needed to determine the efficiency of both types of accelerators. Beam neutralization is a problem peculiar to the ion accelerator. Considerable research and development may be necessary to provide a satisfactory method for neutralizing the ions. An estimate of the power for neutralization is made. The variation of efficiency with specific impulse is discussed. Further experiments are needed to determine the most efficient ranges of specific impulse for both types of accelerators. Erosion is a serious problem in electrical propulsion; however, for a plasma accelerator it may actually be utilized to provide the propellant material.

537.56

12616 METHOD OF MEASURING SIMULTANEOUSLY A CONFINING MAGNETIC FIELD AND THE ELECTRON DENSITY OF A PLASMA.

T.Consoli and D.Lepechinski.

C.R. Acad. Sci. (Paris), Vol. 250, No. 16, 2813-15 (April 20, 1960). In French.

Continuation of previous work [Consoli and Dagai (Abstr. 7112-13 of 1960) and Consoli and Lepechinski (Abstr. 10913 of 1960)]. Describes a possible method for measuring Ne and B when the applied confining magnetic field is uniformly modified by circulating plasma currents.

C.G.Morgan

537.56

12617 OSCILLATIONS AND DIFFUSION IN A FEEBLY IONIZED PLASMA.

J.F.Bonnal, G.Briffod and C.Manus.

C.R. Acad. Sci. (Paris), Vol. 250, No. 17, 2859-61 (April 25, 1960). In French.

Diffusion measurements were made in a 10 cm long 3 cm diameter plasma in hydrogen at pressures between 10^{-3} and 10^{-1} mm Hg in variable axial magnetic field of 0 to 1.5 kG using probes. Below a critical value of the magnetic field particle loss increases and oscillations were observed.

C.G.Morgan

537.56

12618 OBSERVATION OF APPARENT FLUTE-TYPE PLASMA INSTABILITY.

H.Dickinson, W.H.Bostock, J.N.Dimarco and S.Koslov.

Phys. of Fluids, Vol. 3, No. 3, 480-82 (May-June, 1960).

Kerr cell photographs of plasma ejected into uniform and non-uniform magnetic fields in vacuo (10^{-4} mm Hg) reveal a flute-like instability occurring between 1.5 and 4 μsec after ejection.

C.G.Morgan

537.56 : 537.533

12619 THE INTERACTION BETWEEN AN ELECTRON BEAM AND A PLASMA.

I.F.Kharchenko, Ya.B.Fainberg, R.M.Nikolaev, E.A.Kornilov, E.A.Lutsenko and N.S.Pedenko.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 685-92 (March, 1960). In Russian.

Results are presented of an experimental investigation of the interaction between a modulated or an unmodulated beam of high-energy electrons and a high-frequency discharge plasma. It was found that when the unmodulated beam moves through the plasma, oscillations arise in the beam which possess a frequency close to that of the plasma. The dependence of the oscillation amplitude on the frequency and parameters of the plasma was determined. Coherent energy losses of electrons in a modulated and an unmodulated beam passing through the plasma were investigated.

537.56

12620 NONLINEAR OSCILLATIONS AND NONSTATIONARY FLOW IN A ZERO TEMPERATURE PLASMA. I. INITIAL AND BOUNDARY VALUE PROBLEMS.

G.Kalman.

Ann. Phys. (New York), Vol. 10, No. 1, 1-28 (May, 1960).

Two competing processes, the individual motion of particles and the organized medium-like behaviour determine the general motion of a zero-temperature plasma. It is shown that a very strong interaction case corresponds to the linear approximation. Generally, however, the motion is governed by nonlinear equations. On applying a Lagrangian description and by transforming the equations into the coordinate system of the particles, the problem can be solved exactly. The general solution obtained may be fitted to any prescribed boundary or initial value. It is applied to such cases as the velocity modulated stream, oscillations of initial perturbations, velocity modulation in space. Series expansion of the general solution leads to the familiar approximate solutions. At a certain value of the parameters the formation of electrostatic shock waves is possible. The criterion for the incidence of such shock waves is found, and certain features of their motion is given. The structure of the transformed differential equation shows that there is no wave-like propagation in the particles' coordinate system and generally no new particles participate in the motion. The concept of the distortionless oscillation, the results of the linear theory, is untenable in the exact treatment.

537.56

12621 NONLINEAR OSCILLATIONS AND NONSTATIONARY FLOW IN A ZERO TEMPERATURE PLASMA. II. GENERAL CHARACTERISTICS OF THE MOTION.

G.Kalman.

Ann. Phys. (New York), Vol. 10, No. 1, 29-61 (May, 1960).

General nonlinear effects in plasma motion are investigated on the basis of the treatment in Pt I. (1) A travelling-wave solution is studied and the adequate boundary and initial conditions for its excitation are investigated. The dispersion relation in approximation of any order is the same as in the linear theory. It can be shown, however, in virtue of the pertubation method applied, that in the case of a velocity distribution the result does not hold and nonlinear effects alter the dispersion relation. (2) An equipartition is derived between the particle energy and field energy. (3) The development of the original wave-number and frequency spectrum is calculated. A procedure is outlined to calculate contribution of any order to the spectrum. The spectrum can be analysed into higher harmonics of ω_0 and the only nonlinear effect in the development of the wave-number spectrum is the incidence of higher harmonics and no spectral decay or nonlinear dispersion relation exists. An analysis of the time variation of the energy content of the spectrum indicates a behaviour analogous to the "constancy of big eddies" in hydrodynamical turbulence. The differences in the development of the frequenc spectrum are in the lack of simple harmonic relation between wave-numbers which transfer different parts of the spectrum, and in a relative stability of frequencies in the neighbourhood of $\omega = \omega_0$ instead of $\kappa = 0$.

537.56

12622 LINEARIZED PLASMA OSCILLATIONS IN ARBITRARY ELECTRON VELOCITY DISTRIBUTIONS.

G.Backus.

J. math. Phys. (New York), Vol. 1, No. 3, 178-91 (May-June, 1960).

This paper is a mathematical examination of the linearized small disturbances in the steady distribution $f_0(\vec{q})$ of the velocities $\vec{q}$ of the electrons in an electrostatic, collisionless plasma with motionless protons. It is assumed that $g_0(u) = \iint f_0(u,v,w)dvdw$ has an integrable derivative with respect to u for all axis orientations. An existence and uniqueness theorem for the initial value problem i given, and it is shown that no disturbance can grow faster than $\exp\omega_p t$, where ω_p is the electron plasma frequency, Consequently, one can base a stability theory on Laplace transforms with respect to time, as Landau has done (Abstr. 353 of 1947). The limits of validity of Landau's stability criterion are explored: that $g_0(u)$ is table if there are no wave numbers k for which

$$\mathcal{L}(s) = k^2\omega_p^{-2} - \int_{-\infty}^{\infty} g_0'(u)\,(u-s)^{-1}du$$

as zeros in the upper complex s half-plane. To ensure instability, ne zeros must have positive imaginary parts or a multiplicity of 2 r greater. To ensure stability, the initial disturbance must be not nly integrable, but square integrable with respect to u. The Max-ell distribution is unstable to certain integrable disturbances. All sotropic, three-dimensional distributions $f_0(\vec{q}) = h(q^2)$ for which $^{1/4}h(x)$ is absolutely continuous and square integrable, and (x) + 2xh'(x) is bounded, are stable to integrable, square integrable isturbances. This explains Van Kampen's (Abstr. 3042 of 1956) bility to solve the initial value problem by superposing normal odes (solutions with complex, exponential time dependence) with eal frequencies; he implicitly introduced stability by considering nly isotropic distributions $f_0(q)$. His method is extended to unstable as a technique independent of Landau's for solving the initial value roblem. If f_0 is unstable, the normal modes are not complete, and normal mode analysis can lead to erroneous positive conclusions bout stability. Finally, the linear theory predicts that in stable lasmas the neglected term will grow linearly with time at a rate roportional to the initial disturbance amplitude, destroying the alidity of the linear theory, and vitiating positive conclusions about tability based on it. In a thermonuclear plasma with T = 10^8 °K nd N = 10^{15} electrons/cm^3, a disturbance of wavelength 1 cm and nitial amplitude 1 V can no longer be treated by the linear theory fter 220 μsec.

537.56

12623 LARGE AMPLITUDE WAVES IN A COLLISION-FREE PLASMA. I. SINGLE PULSES WITH ISOTROPIC RESSURE.

A.Baños,Jr. and R.Vernon.

uovo Cimento, Vol. 15, No. 2, 269-88 (Jan. 16, 1960).

Considers an infinite expanse of low density, fully ionized plasma, agnetically immobilized in a constant and uniform field of magnetic nduction. In the absence of collisions it is assumed that the ion and lectron motions take place in planes perpendicular to the magnetic ield. It is then transformed to a "shock" frame of reference moving t constant speed at right angles to the magnetic field, and then a earch is made for the class of non-trivial, time independent, one-imensional, self-consistent solutions of the Maxwellian set and of he equations of motion of the charged particles; that is, the propa-ation of transverse pulses and waves are studied whose character-stic length is much smaller than the collision mean free path. Making appropriate simplifications leads to a system of equations which collisions are neglected, charge neutrality is assumed, and oth ions and electrons behave like two-dimensional fluids obeying sentropic relations with $\gamma = 2$ and exhibiting rigorously isotropic ressure tensors. With these simplifications and assumptions, the ystem of equations can be solved completely by a simple numerical uadrature. Both symmetric pulses and periodic waves are obtained, ith characteristic lengths of the order of the plasma "skin depth", r mean gyromagnetic radius for particles travelling with the Alfvén peed. In this, Pt I, the solitary pulses are described, which are the nly solutions satisfying the conditions of the undisturbed plasma head of the wave train. Two basic parameters are required for a omplete specification of the problem: the Alfvén Mach number α, hich gives a measure of the speed of propagation, and the ratio β of he total plasma pressure to the magnetic pressure, which specifies he initial state of the plasma. It is shown that, for given β, station-ry solutions exist only for a limited range of speeds α.

537.56

12624 PLASMA OSCILLATIONS PERPENDICULAR TO A CONSTANT MAGNETIC FIELD.

I.B.Bernstein.

hys. of Fluids, Vol. 3, No. 3, 489-90 (May-June, 1960).

It is argued that the author's Laplace transform method of eriving the dispersion relations for longitudinal plasma oscilla-ons is valid contrary to the recent criticism by Oster (Abstr. 9048 f 1960). D.Walsh

537.56

12625 INSTABILITY OF LONGITUDINAL OSCILLATIONS OF AN ELECTRON—ION PLASMA.

.M.Kovrizhnykh and A.A.Rukhadze.

h. eksper. teor. Fiz., Vol. 38, No. 3, 850-3 (March, 1960). In ussian.

The problem of instability of longitudinal oscillations of a low-mperature electron—ion plasma is considered. The oscillations are always damped in an isotropic medium whereas in an anisotropic allowance for the ion motion may lead to unstable solutions (which increase with time).

537.56 : 534.22

ULTRA-HIGH-SPEED PHOTOGRAPHS REFUTING "COHESION IN PLASMA". See Abstr. 12457

[illegible]

GYRORESONANCE ABSORPTION OF ELECTROMAGNETIC WAVES IN A PLASMA. See Abstr. 12707

537.56 : 538.56

GROWTH OF ELECTROMAGNETIC WAVES IN A PLASMA MOVING IN A NONDISPERSIVE DIELECTRIC IN A CONSTANT MAGNETIC FIELD. See Abstr. 12708

ELECTRON EMISSION
ELECTRON BEAMS

537.533 : 621.385.032.212.63

12626 THERMIONIC PROPERTIES OF UC.

G.A.Haas and J.T.Jensen,Jr.

J. appl. Phys., Vol. 31, No. 7, 1231-3 (July, 1960).

Thermionic emission measurements using pulse techniques were obtained from UC-coated W filaments in the temperature range of 1200°-2100°K. From the slope and intercept of the Richardson plot, a value of ϕ = 2.94 eV and A = 33 A cm^{-2} deg^{-2} was indicated. There is evidence that the energy required for electrons to escape at low fields might be several tenths eV higher than the 2.94 eV value.

537.533 : 539.2 : 537.311

12627 PHOTOEMISSION FROM SI INDUCED BY AN INTERNAL ELECTRIC FIELD.

R.E.Simon and W.E.Spicer.

Phys. Rev., Vol. 119, No. 2, 621-2 (July 15, 1960).

External photoelectric emission from silicon with a threshold of response corresponding to the band gap (1.05 eV) was observed from a back-biased p—n junction which had received a caesium surface treatment. This emission current is proportional to the intensity of the incident light. The spectral distribution of this field induced photoemission is simply related to the spectral distribution of the fundamental absorption of silicon.

537.533

12628 MEASUREMENTS OF THE SECONDARY ELECTRON EMISSION OF KCl AND KBr.

B.Petzel.

Ann. Phys. (Leipzig), Vol. 6, No. 1-2, 55-66 (1960). In German.

Single-pulse technique measurements were made on KCl and KBr single crystals and on evaporated KCl layers. For high primary electron energies the secondary emission ratio decreases between room temperature and 300°C. For small primary electron energies the yield is independent of temperature. The secondary electron energy distribution depends on the primary electron energy.
G.F.J.Garlick

537.533

12629 SECONDARY ELECTRON EMISSION OF ANTIMONY—CAESIUM AND BISMUTH—CAESIUM LAYERS OF VARIOUS COMPOSITIONS.

G.Appelt and O.Hachenberg.

Ann. Phys. (Leipzig), Vol. 6, No. 1-2, 67-81 (1960). In German.

The secondary electron yield, its temperature dependence and its energy distribution are studied for Sb—Cs and Bi—Cs layers. Besides Cs_3Sb with high yield, CsSb was studied showing little temperature dependence and a yield not much greater than antimony. For Bi—Cs, the Cs_3Bi and $CsBi_2$ systems give about the same emission. Change in emission with composition can be related to a change in work function. G.F.J.Garlick

537.533

12630 SECONDARY ELECTRON EMISSION OF ANTIMONY—RUBIDIUM LAYERS.

W.Kaneff.

Ann. Phys. (Leipzig), Vol. 6, No. 1-2, 82-8 (1960). In German.

Static secondary emission measurements were made on polycrystalline layers of antimony—rubidium with different proportions of the metals. The yield maximum lies at higher primary

electron energies as the rubidium content is increased. Increase in Rb atom additions to pure antimony increases the number of slow electrons and the energy distribution peak shifts to lower values. The yield for $RbSb_2$ and Rb_3Sb is almost independent of temperature.
G.F.J.Garlick

537.533

12631 SECONDARY ELECTRON EMISSION AND ELASTIC REFLECTION OF ELECTRONS FROM SINGLE CRYSTALS OF GERMANIUM FOR LOW-ENERGY ELECTRONS. A.R.Shul'man and D.A.Ganichev.
Fiz. tverdogo Tela, Vol. 2, No. 3, 530-6 (March, 1960). In Russian.

Describes apparatus for measuring the secondary electron emission ratio of germanium for incident electrons in the range 1-50 eV. A pressure of better than 10^{-8} mm Hg was maintained during the measurements. It was found that the secondary emission characteristics of single crystals of germanium differ considerably from those of evaporated layers and, in fact, possess a fine structure.
T.Mulvey

537.533 : 537.7 : 621.385.032.213.13 : 621.317.332.1

A NEW METHOD FOR THE MEASUREMENT OF CATHODE INTERFACE IMPEDANCE. See Abstr. 12566

537.533

12632 SECONDARY EMISSION FROM METALLIC SURFACES BOMBARDED WITH POSITIVE IONS. N.N.Petrov.
Fiz. tverdogo Tela, Vol. 2, No. 5, 940-8 (May, 1960). In Russian.

Secondary emission from Mo, W, and Ni targets (purified by prolonged vacuum annealing), bombarded with Zn and Cd ions (0.3-1.0 keV), and from Ta, bombarded with positively charged H, He (1-30 keV), and A (1-7.5 keV) ions was studied. Potential removal of secondary electrons from Mo and W, but not from Ni, was observed, the coefficient γ not exceeding a few %. There was no ejection of electrons from W due to the kinetic energy of incident ions. In the low-energy range of the incident ions ($E < 5$ keV) of H, He, and A, the relationship $\gamma = f(E)$ was linear, the rate of increase of γ becoming slower at higher E. The coefficient K of the ion—ion emission was small ($< 10\%$) and independent of E. M.H.Sloboda

537.533

12633 ANGULAR DISTRIBUTION OF SECONDARY ELECTRONS FROM (100) FACES OF COPPER AND NICKEL. J.Burns.
Phys. Rev., Vol. 119, No. 1, 102-14 (July 1, 1960).

The angular distributions were measured for secondaries in four energy ranges (0-10, 10-20, 20-40 and 40-90 eV) for primary electron energies of 250, 500 and 800 eV. Fine structure was observed which consisted of weak peaks in the angular distribution superimposed on a background having approximately a cosine distribution. After making corrections for the refraction of secondaries at the surface of the crystal, the internal angular distribution peaks fall along principal low-index directions in the crystal as suggested in the quantum-mechanical collision theories of Wooldridge and of Dekker and van der Ziel. The positions, intensities, and widths of the peaks cannot be accounted for in terms of diffraction of the internal secondaries. The observed peaks are believed to be secondaries produced in the initial collision between the primary electron and a lattice electron of the crystal, enough of these secondaries having escaped the crystal without further collisions to make their observation possible. Details of the angular distribution are in agreement with collision theory based on a screened Coulomb interaction with a velocity-dependent screening length. The velocity dependence of the screening coefficient in the screened Coulomb interaction leads to a sharp drop in the inelastic cross-section for energy transfers larger than the plasma excitation energy, and it also leads to increased probability for collisions in which the primary suffers only small deflections. The role of the band structure of the crystal in determining the features of the collision is discussed. In Cu and Ni the vacuum level of potential lies in the second Brillouin zone, so only interzone (umklapp) transitions can lead to secondary electron emission from these metals. Surface refraction is treated in terms of a velocity dependent refractive index, and the experiment offers a means of determining the velocity dependence of the index. Experimental procedures and precautions required to observe the angular distribution fine structure are discussed.

537.533

12634 BACK SCATTERING AND SECONDARY EMISSION DURING β-ELECTRON IRRADIATION OF DIFFERENT MATERIALS. Yu.A.Simchenko.
Radiotekhnika i Elektronika, Vol. 4, No. 8, 1381-6 (Aug., 1959). In Russian.

Describes the equipment and results of direct measurements on cylindrical collectors of materials of different atomic numbers (Fe, Cu, Ni ... W, Au) when irradiated by $Sr^{90}—Y^{90}$ β-electrons from a source of 210 mc activity. The figures obtained for reverse scattering and secondary emission are compared with those got by using an end-type counter and by measuring the scattering from plane targets of beams with electron energies 1 and 1.2 MeV. The end-type counter figures for scattering are shown to be considerably higher than the directly measured figures, whilst the total reverse electron radiation collector current is practically independent of the amount of secondary emission from the surface. D.E.Brown

537.533 : 539.18

ELECTRON SCATTERING IN THE ELECTRON MICROSCOPE. See Abstr. 11505

537.533 : 621.385.64

12635 STATISTICAL EQUILIBRIUM OF AN ELECTRON SPACE-CHARGE WITH CYLINDRICAL SYMMETRY IN A MAGNETRON VALVE. J.Coste and L.Dagens.
C.R.Acad. Sci. (Paris), Vol. 250, No. 18, 3009-11 (May 2, 1960). In French.

The method of the most probable phase distribution is applied to the cut-off magnetron with zero emission velocity. Numerical integrations giving the space-charge density in the case of vanishing cathode diameter have been performed and an example is plotted.
A.H.W.Beck

537.533 : 621.385.833

12636 POWER FLOW AND STORED ENERGY IN THIN ELECTRON BEAMS. W.W.Rigrod.
J. appl. Phys., Vol. 31, No. 7, 1147-53 (July, 1960).

The kinetic and electromagnetic components of a.c. power and stored energy are evaluated for space-charge waves along thin drifting beams of simple geometry. It is found that: (a) when a modulated beam is decelerated, it radiates power into the surrounding space; (b) when both fast and slow waves are excited by a commo source, the real kinetic power varies periodically with distance, exchanging energy with the electromagnetic field; and (c) when a finite-area beam is current modulated with zero a.c. velocity, the total power need not be zero. The energy transport velocity of a space-charge wave is shown to equal its group velocity, when the time-average stored energy is properly evaluated. A small portion of the stored kinetic energy propagates, together with the field energy, as an electromechanical wave along the beam. The larger part of the kinetic energy, which can be positive of negative, is transported by the motion of the beam itself.

537.533 : 537.56

THE INTERACTION BETWEEN AN ELECTRON BEAM AND A PLASMA. See Abstr. 12619

537.533

12637 BEAM REFRIGERATION BY MEANS OF LARGE MAGNETIC FIELDS. R.Adler and G.Wade.
J. appl. Phys., Vol. 31, No. 7, 1201-3 (July, 1960).

The resistive loading which an electron beam produces in an adjacent structure can be made to exhibit a very low noise temperature. This is achieved by coupling to the fast cyclotron wave in a large magnetic field; the noise temperature at a given signal frequency is shown to be equal to the cathode temperature times the ratio of signal frequency to cyclotron frequency. An experiment is described in which this ratio is $\frac{1}{6}$. The coupling structure interacts with the fast cyclotron wave but rejects the slow cyclotron wave. A noise temperature of 186°K is measured. In conclusion, it is shown that the large magnetic field required for beam cooling need not extend throughout the tube.

537.533 : 537.534

12638 NUMERICAL DETERMINATION OF THE TRAJECTORIE OF CHARGED RELATIVISTIC PARTICLES IN ELECTRI AND MAGNETIC FIELDS. N.I.Shtepa.
Zh. tekh. Fiz., Vol. 30, No. 1, 121-4 (Jan., 1960). In Russian.

A numerical extrapolation method is applied directly to obtain

he solution of a system of second-order differential equations. he accuracy is estimated through given recurrence relations.
P.K.Kabir

537.533

12639 **SPHERICAL ABERRATION COEFFICIENT OF ASYMMETRICAL MAGNETIC ELECTRON LENSES.**
.Barthére, J.Dugas and P.Durandeau.
.R.Acad. Sci. (Paris), Vol. 250, No. 21, 3461-3 (May 23, 1960).
n French.

The spherical aberration coefficient has been calculated for a eries of magnetic lenses in which the ratio of the bores (D_1/D_2) of he pole-pieces varied from 1 : 3 to 3 : 1, whilst their sum ($D_1 + D_2$) vas constant and equal to the separation of the pole-pieces S. The xial field distributions needed for the calculation were taken from he measurements of Durandeau, Fagot, Barthere and Laudet J. Phys. Radium, Vol. 20, No. 7, 80A, 1959). A similar calculation or symmetrical lenses was in good agreement with the results of iebmann and Grad (Abstr. 1851-2 of 1952). V.E.Cosslett

537.533 : 539.12

MICRO-FOCUS ELECTRON TUBE FOR X-RAY MICROSCOPY.
ee Abstr. 11138

537.533 : 539.18

SCATTERING OF ELECTRONS BY LIGHT ATOMS. See
Abstr. 11504

ION EMISSION . ION BEAMS

537.534

12640 **A NEGATIVE ION SOURCE.**
Ya.M.Fogel', A.G.Koval' and A.D.Timofeev.
Zh. tekh. Fiz., Vol. 29, No. 11, 1381-7 (Nov., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 11, 1270-7 (May, 1960).

Gives constructional details of a hot-cathode ion source, a mercury vapour charge-exchange chamber and an electrostatic focusing system. The output beam is analysed magnetically and then focused by a pair of electrostatic quadrupole lenses. The dependence of the output current on various parameters (e.g. extraction voltage, mercury vapour target density) is given. A focused negative hydrogen ion current of 20 μA in a 6 mm diameter beam was obtained. It was measured on a Faraday cup placed near the quadrupole lenses. The maximum negative helium ion current was 0.18 μA and negative oxygen ion current was 40 μA. Cathode life varied between 20 and 40 hours depending on the gas used.
J.W.Sturgess

537.534

12641 **ON THE ENERGY DISTRIBUTION OF IONS FROM A HIGH-FREQUENCY ION SOURCE.** G.Forst.
Z. Phys., Vol. 159, No. 1, 7-18 (1960). In German.

Investigates the discrepancy between observed energy-distribution of hydrogen ions and that predicted by Langmuir's probe theory (Abstr. 1003 of 1928). After discussion and rejection of six other xplanations, describes experiments using a retarding-field grid, a Faraday cage and a thermocouple as energy-indicator, which show hat the anomalous higher energies are due in the main to single exchanges of charge between an ion and neutral atom in the space etween the plasma boundary and orifice. The energy distributions f ions and neutral atoms are separated. Some subsidiary lower-energy maxima in the energy-distribution curves are unexplained. The experimental method differs from the usual ones in measuring energy rather than current as a function of retarding potential.
B.Meltzer

537.534

12642 **THE MASS ANALYSIS OF A HIGH-FREQUENCY ION SOURCE FOR A VAN DE GRAAFF ACCELERATOR.**
E.Cilenšek, F.Cvelbar and V.Ramšak.
"J. Stefan" Inst. Rep., Vol. 3, 87-94 (Oct., 1956). In German.

537.534 : 537.56

FORMATION OF PROTONS IN ION SOURCES.
See Abstr. 12582

537.534 : 533.5

12643 **ADJUSTABLE GAS LEAK.**
V.Ivković and G.Mavrodiev.
"J. Stefan" Inst. Rep., Vol. 5, 29-31 (Oct., 1958).

An adjustable gas leak, developed for the ion source of a 2 MV Van de Graaff accelerator, is described in detail. The control of the flow rate is obtained by the thermal expansion of a metal wire, heated by a small electric current. The functioning of the leak and its properties are compared with the other types of leak used commonly for the same purpose.

537.534

12644 **EXPERIMENT TO OBTAIN REACTION THRUST IN A LABORATORY MODEL OF AN ION ENGINE.**
Yu.Ya.Stavisskii, I.I.Bondarenko, V.I.Krotov, S.Ya.Lebedev, V.Ya.Pupko and É.A.Stumbar.
Zh. tekh. Fiz., Vol. 29, No. 8, 962-6 (Aug., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 875-8 (Feb., 1960).

A model ion engine has been constructed, having a thrust of 0.5 gramme wt. This makes use of an accelerated beam of caesium ions emitted from a hot tungsten-caesium surface. The thrust is measured directly, and is found to agree well with the theoretical value. A.H.Gabriel

537.534

12645 **THE PENETRATION OF POSITIVE IONS OF LOW ENERGY INTO ALLOYS AND COMPOSITION CHANGES PRODUCED IN THEM BY SPUTTERING.** E.Gillam.
J. Phys. Chem. Solids, Vol. 11, No. 1-2, 55-67 (Sept., 1959).

Thin sheets of the alloy Cu_3Au were prepared so that electron-diffraction patterns could by obtained from them by transmission. After bombardment of the alloy with argon ions of various energies up to 5000 eV, the diffraction patterns consisted of distinct doublets, indicating the formation of a layer with a composition different from that of the original alloy. Initially, the sputtering produced a thin layer of alloy, uniform in composition and more gold-rich than Cu_3Au; subsequent sputtering under identical conditions eroded three times as much copper as gold from the surface. Helium and xenon ions were also used to show that the composition and thickness of the layer both depend on the size of the ion and its energy. Some other alloys developed altered layers. It was shown that with silver—palladium alloys the composition of the altered layer also depends on the composition of the original alloy. The thickness of the altered layer is taken to be a measure of the penetration of the ions. A discussion of current theories of radiation damage shows that they do not account fully for the observations.

537.534

12646 **ON THE MOTION OF A CHARGED PARTICLE IN AN ALMOST HOMOGENEOUS MAGNETIC FIELD.**
L.J.F.Broer and L.van Wijngaarden.
Appl. sci. Res. B, Vol. 8, No. 3, 159-76 (1960).

First, the motion of a particle in a slowly varying homogeneous field is studied. An expansion is given for the dominating spiralling part of the motion. It is found that the centre of this motion will drift slowly. Calculation of the drift amounts to the determination of the reflection in an equivalent wave propagation problem. Next, the motion in constant, nearly homogeneous fields is treated, partly using the same method. In a few representative cases it is shown that the first approximation reproduces results given by Alfven (1950) and by Spitzer (1956), while some results are given in second approximations.

537.534 : 537.533

TRAJECTORIES OF CHARGED RELATIVISTIC PARTICLES.
See Abstr. 12638

537.534

12647 **CHARGED-PARTICLE ORBITS IN VARYING MAGNETIC FIELDS.** E.I.Gordon.
J. appl. Phys., Vol. 31, No. 7, 1187-90 (July, 1960).

A solution for the paraxial orbits of charged particles in varying magnetic fields is given. The magnetic field is assumed to be azimuthally symmetric but is allowed to vary arbitrarily with time or axial distance. The instantaneous guiding centre and radius vector of the orbit are given in terms of the initial guiding centre and radius vector and two parameters which are determined from the solution of a first-order differential equation containing the magnetic-field variation. One exact and two approximate constants of the motion are evaluated and discussed.

537.534 : 538.3

ORBIT CALCULATIONS IN PARTICLE OPTICS: PERFECT IMAGING SYSTEMS. See Abstr.12679

537.534

12648 NUMERICAL CALCULATION OF THE POTENTIAL DISTRIBUTION IN ION SLIT LENS SYSTEMS. III.

A.J.H.Boerboom.

Z. Naturforsch., Vol. 15a, No. 3, 253-9 (March, 1960).

The computing methods are generalized to slit systems of an arbitrary number of electrodes, the only restrictions being that slits broader than the distances to neighbouring slits are separated by slits narrower than the respective distances, and that a pair of electrodes with a mutual distance smaller than their slit widths are separated from the neighbouring slits by distances greater than the respective slit widths. For slit systems satisfying this condition, the parameters are computed which are necessary to perform the Schwarz-Christoffel transformation. Formulae are given to compute the potential distribution and field strength. In a typical example the potential distribution and field strength are computed in the region around two parallel electrodes with slits broad compared with the distance between the electrodes. For Pt II see Abstr. 10985 of 1960.

537.534

12649 THE THREE-STAGE RADIO FREQUENCY MASS SPECTROMETER. M.Ribarič.

"J. Stefan" Inst. Rep., Vol. 3, 105-34 (Oct., 1956).

The purpose of the present paper is to give a detailed analysis of the operation of a three-stage radio-frequency mass spectrometer and of the role played by some of its parameters. In Part I the operation of such a radio-frequency mass spectrometer is explained. A study is made of the influence of the voltage applied to the radio-frequency accelerating stages and the role of the spacings between the latter. It has been found that the resolving power of a radio-frequency mass spectrometer and the ratio between the heights of the energy gain maxima depend on these parameters. In Part II the influence of the netlike field structure of the radio-frequency accelerating stages is analyzed. Part III deals with the influence of the inhomogeneity of single potentials upon the resolving power and the shape of the resonance curve. The results obtained are in satisfactory agreement with the measurements.

537.534

12650 MAGNETIC MASS SPECTROMETER. L.Furman and V.Vrščaj.

"J. Stefan" Inst. Rep., Vol. 4, 109-15 (Oct., 1957).

A description is given of the construction, operation and performance of the magnetic mass spectrometer built at the J.Stefan Institute.

537.534

12651 WORKABLE MAGNETIC SHIM TO CORRECT SECOND-ORDER ABERRATION IN A MASS SPECTROMETER.

S.J.Balestrini and F.A.White.

Rev. sci. Instrum., Vol. 31, No. 6, 633-6 (June, 1960).

A simple magnetic shim has been developed and tested to obtain second-order focusing in an existing conventional mass spectrometer of the magnetic sector type. An easily applied formula is developed for its fabrication from a sheet of thin magnetic material, and a practical method for its alignment is discussed. The improved second-order focusing obtained is demonstrated by displaying the spectrometer signal directly on an oscilloscope. The property of the shim to correct defocusing due to spectrometer misalignment is demonstrated.

537.534 : 539.18

12652 THE MAGNETO-IONIC EXPANDER ISOTOPE SEPARATOR APPLIED TO URANIUM. J.Slepian.

Nuclear Sci. Engng, Vol. 3, No. 1, 108-10 (Jan., 1958).

537.534

12653 SPUTTERING THRESHOLDS AND DISPLACEMENT ENERGIES. R.V.Stuart and G.K.Wehner.

Phys. Rev. Letters, Vol. 4, No. 8, 409-10 (April 15, 1960).

Briefly describes a spectroscopic method for determining sputtering yield versus ion energy (for ion energies <300eV) by which yields down to 10^{-4} atom per ion may be readily measured. Typical results for A^+ and Hg^+ on Cr are given graphically. For most of the 20 metals investigated, the product of threshold energy for sputtering and energy transfer factor is close to the displacement threshold for radiation damage. J.Dutton

537.534 : 537.56

SCATTERING OF MULTIPLY-CHARGED IONS. See Abstr. 12590

PARTICLE ACCELERATORS

537.54 : 539.1.07

12654 THE PRODUCTION AND USE OF BEAMS OF PARTICLES FROM HIGH-ENERGY ACCELERATORS. W.H.Barkas.

"Particle photography" Conference. Montreal, 1958 (See Abstr. 2261 of 1960) p. 413. In French.

A summary of methods used to obtain beams suitable for the study of a elementary particles by means of nuclear emulsions. Focusing and separation techniques are considered together with the instrumentation required for each type of separator. Factors limiting the quality of the beams are briefly examined. S.J.St-Lorant

537.54 : 621.319.523

12655 IMPROVED VERSIONS OF THE CASCADE GENERATOR. G.Reinhold, J.Seitz and R.Minkner.

Z.InstrumKde, Vol. 67, No. 10, 258-65 (Oct., 1959). In German.

An analysis of the conventional Cockroft—Walton cascade generator leads to the conclusion that ripple and losses limit the maximum output to approximately 2 MeV. It is shown that a modified, symmetrical version can reach very much higher voltages. Some details of a 4 MeV machine constructed by the authors are given. E.A.Ash

537.54 : 621.372.852.2

12656 S-BAND ISOLATOR FOR USE WITH A LINEAR ACCELERATOR. C.S.Gaskell and D.Walsh.

Brit. J. appl. Phys., Vol. 10, No. 1, 53-4 (Jan., 1959).

Construction and performance of a high-power S-band isolator is described. A satisfactory performance using a manganese—magnesium aluminized ferrite is obtained for peak powers around 1 MW. A.E.Karbowiak

537.54

12657 MEASUREMENT OF THE BREMSSTRAHLUNG SPECTRUM FROM A 30 MeV BETATRON WITH A COMPTON ELECTRON SPECTROMETER.

U.Miklavžič and Č.Zupančič.

"J. Stefan" Inst. Rep., Vol. 5, 3-8 (Oct., 1958).

The spectrum of bremsstrahlung from the Brown—Boveri betatron has been measured at the energy of 30 MeV using a magnetic Compton electron spectrometer.

537.54

12658 EFFECTIVENESS OF DIFFERENT PORTIONS OF THE INJECTION PULSE FOR ELECTRON CAPTURE IN A BETATRON. D.P.Ivanov and Yu.S.Korobochko.

Zh. tekh. Fiz., Vol. 29, No. 11, 1414-15 (Nov., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York) Vol. 4, No. 11, 1304 (May, 1960).

Suggests that differences of results (Abstr. 9129 of 1960) can be caused by a reduction of emissivity of some complex cathodes during the application of short-voltage pulses. The same effect can be caused by a small phase difference between the potentials applied to the cathode and the Wehnelt electrode. J.W.Sturgess

537.54

12659 BETATRON OSCILLATIONS IN AN ACCELERATOR WITH A GENERAL FIELD. I. J.Teichman.

Czech. J. Phys., Vol. 10, No. 2, 144-57 (1960). In Russian.

A linear theory is given of equilibrium trajectories in an accelerator with a generalized magnetostatic field, the components of which are defined on a general surface of rotation. Equations of motion of the particles in natural coordinates are derived with respect to the change in energy and dissipative force. A system of equilibrium trajectories is found in the general form. Conditions are derived for the field components on the reference surface, necessary for the existence of equilibrium trajectories, for the conservation of their geometric similarities and for maintaining the constancy of the frequencies of the betatron oscillations. A condition is also derived which must be satisfied by the reference surface in order o conserve constant circular frequency of the particles. It is seen hat it is not possible to find a field for a accelerator with an exactly onstant circular frequency and with constant frequencies of the etatron oscillation in the relativistic energy region. An ultra-elativistic cyclotron with such properties is realizable.

537.54

12660 STATISTICAL ELECTRON CAPTURE MECHANISM IN BETATRONS. M.Seidl.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1305-6 (April, 1959).
n Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 924-5 (Oct., 1959).

As the injected electrons approach statistical equilibrium, losses o the walls and to the injector "cool" the beam, resulting in a de-crease of cross-section. Since the relaxation time covers many revolutions, the number of electrons captured into orbits increases with the mean life of the injected electrons, which is longer for small njection currents. S.E.Hunt

537.54

12661 THE DAMPING OF PHASE OSCILLATIONS IN A WEAK-FOCUSING SYNCHROTON. R.Klíma.
Czech. J. Phys., Vol. 10, No. 2, 136-43 (1960). In Russian.

An equation of the phase oscillations is derived for the case where an arbitrary high-frequency field of sinusoidal time dependence s distributed on the circumference of the accelerator. It is shown hat the damping of phase oscillations is practically independent of he shape of the high-frequency field. From this the special case is lerived where any adjustments to the accelerator gaps (considered, or example in Abstr. 9128 of 1960) are useless.

537.54 : 539.12

12662 COHERENT RADIATION OF ELECTRONS IN A SYNCHROTRON. III. M.S.Rabinovich and L.V.Iogansen.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1183-7 (April, 1960).
In Russian.

For Pt. II, see Abstr. 9124 of 1960. Electromagnetic interaction of electrons in a synchrotron is considered, allowing for the shielding action of the chamber walls on a bunch of arbitrary shape. The effect of these forces on the electron phase motion and the size of the bunch is estimated.

537.54 : 539.12

HIGH-ENERGY NEUTRINO STUDIES: CAPABILITIES OF PRESENT ACCELERATORS. See Abstr. 11140

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

538

12663 THE "REPTOGRAPH" FOR AUTOMATIC RECORDING OF ACCOMMODATION PHENOMENA OF MAGNETIZATION. G.Bonnet, D.Dautreppe and R.Gariod.
J. Phys. Radium, Vol. 20, No. 2-3, 229-32 (Feb.-March, 1959). In French.

The reptograph is an apparatus intended for studying the transient effects representing magnetization accommodation in a ferromagnetic body. The recording process is continuous, and can be continued for a duration of 1 sec with a precision better than 1%. The cycle of measurement is rendered automatic by a new type of demagnetizing equipment and a programming device.

538

12664 SIMPLE TRANSDUCER TYPE MAGNETIC BALANCE. R.C.Vickery and W.C.Sexton.
Rev. sci. Instrum., Vol. 31, No. 6, 647-9 (June, 1960).

A modified Sucksmith balance is described in which a displacement transducer, linked to a flat spiral spring, replaces the conventional optical system. Voltage output from the transducer may be metred or read by oscillograph. A furnace-cryostat assembly associated with the balance head is also described.

538 : 621.395.625.3

12665 ANALYSIS OF A PRACTICAL PERPENDICULAR HEAD FOR DIGITAL PURPOSES. G.J.Y.Fan.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 402S-403S (May, 1960).

The potential field around a perpendicular recording head is studied by a Fourier method. As this potential function obtained is easy to operate, the wavelength response of the head can be calculated and is shown to be similar to that of a ring head for a recorded sine wave. The first term of the expansion of the flux through the head is sin x/x. This term is nominally not affected by spacing; thus, the head has good reliability. Some perpendicular recording heads were built and a reasonably good response curve obtained. However, the main drawback of such a head, in a standard tape system, lies with the recording process, i.e., a wavelength loss on tape rather than a limitation of the playback head. Since there is no essential difference between sine-wave and digital recording, the analysis can easily be extended to a digital system.

538

12666 HIGH SPEED MAGNETOOPTICAL MEASUREMENTS ON FILMS.
P.C.Archibald, R.L.Conger, R.W.Sharp and J.L.Tomlinson.
Rev. sci. Instrum., Vol. 31, No. 6, 653-5 (June, 1960).

An electronic strobing magnetooptical apparatus has been developed which makes it possible to observe the magnetization reversal process in thin films with reversal taking place in 1 μsec. Reversal takes place in a nonuniform manner starting at film edges and imperfections.

538 : 621.317.44

12667 SENSITIVE FLUX MEASUREMENT OF THIN MAGNETIC FILMS. H.J.Oguey.
Rev. sci. Instrum., Vol. 31, No. 7, 701-9 (July, 1960).

The two main difficulties encountered in the design of a sensitive hysteresis loop tracer for thin magnetic films are the flux calibration and the reduction of noise. The study of the flux distribution around a thin magnetic film specimen permits determination of the merits of various pickup coil configurations, as well as the form which optimizes the signal-to-noise ratio. The various disturbing voltages and the ways to eliminate them are examined. Optimization of the amplifier noise figure, proper choice of the integration network, d.c. restoration, and hum synchronization are described for the reduction of the output noise after integration and amplification. Two instruments built according to these principles are outlined. The first has a single wire pickup and is well suited for measurement of the flux distribution around a thin magnetic film and for experiments in vacuum at elevated temperatures; the second is more flexible and sensitive. By using different pickup coils covering a frequency range from 50 c/s to 10kc/s its sensitivity is sufficient to measure flux values of 2×10^{-12} V/s at a frequency of 500 c/s.

538 : 621.395.625.3

12668 AN AUTORADIOGRAPHIC METHOD FOR DETERMINING THE DISTRIBUTION OF IRON ON RECORDING TAPE.
S.M.Makin and A.E.Nunley.
Internat. J. appl. Radiation and Isotopes. Vol, 7, No. 2, 123-5 (Dec., 1959).

Autoradiography was found to be a suitable method for measuring the distribution of iron in the magnetic coating on recording tape. Non-uniformity was found on a macroscopic and microscopic scale. Autoradiographs taken with Fe^{55} and Fe^{59} revealed irregularities over distances of 1 to 3 mm and further non-uniformity was found on 5μ scale.

538.1

12669 SPIN WAVES AND THEIR DISPERSION IN ANTI-FERROMAGNETICS AND FERROMAGNETICS FOR VARIOUS TYPES OF SUPERSTRUCTURE. S.Szczeniowski and H.Cofta.
J. Phys. Radium, Vol. 20, No. 2-3, 148-50 (Feb.-March, 1960). In French.

The ideas of natural superstructure and regular superstructure introduced by Cofta (see Abstr. 9752 of 1959) are used. The general dispersion formula for spin waves in ferrimagnetic translation lattices, derived by means of semi-classical methods, leads to an anisotropic dispersion law in the case of such non-natural regular superstructures. This superstructural anisotropy appears clearly in the formulae for the case of antiferromagnetics. In order to decide the experimental observability of this anisotropy, the values of the exchange integrals between the nearest and the next-nearest neighbours must be known (at least approximately). The semi-classical analysis of non-regular superstructures leads to the conclusion that the antiferromagnetic sublattices in such superstructures cannot be mutually coupled. The behaviour of the only known antiferromagnetic with non-regular superstructure, namely MnO_2, confirms the above result.

538.27

12670 THE ENTROPY OF SPIN SYSTEMS IN NUCLEAR MAGNETIC RESONANCE. I. G.Vojta.
Ann. Phys. (Leipzig), Vol. 6, No. 1-2, 31-43 (1960). In German.

A detailed consideration of the entropy of a spin system in the presence of both a steady and an alternating magnetic field by the density matrix method. The validity of the entropy concept in this application of irreversible thermodynamics is considered and a formulation due to Wangsness (Abstr. 2993 of 1956; 2459 of 1957) discussed. J.G.Powles

538.27

12671 THE FORM OF PARAMAGNETIC RESONANCE LINES AND THE DIRECT MEASUREMENT OF THE MOMENTS. J.Hervé.
Ann. Phys. (Paris), Ser. 13, Vol. 5, No. 3-4, 321-64 (March-April, 1960). In French.

A thesis which describes a method of obtaining directly the moments of electron spin resonance lines by measuring electronically the harmonics of a suitably modified signal. Experimental details and the results of some measurements on carbon, DPPH, etc., are given. J.G.Powles

538.27

12672 STUDY OF THE BLOCH—SIEGERT EFFECT IN WEAK MAGNETIC FIELDS. H.Benoit and H.Ottavi.
C.R. Acad. Sci. (Paris), Vol. 250, No. 17, 2886-8 (April 25, 1960). In French.

Existing theoretical expressions for the change in nuclear magnetic resonance frequency brought about by a large alternating magnetic field, perpendicular to the steady polarizing field H_0, were confirmed experimentally. A small value of H_0, of the order of 3 gauss, was used so as to obtain more readily a large relative change. E.F.W.Seymour

ELECTROMAGNETISM
MAGNETOHYDRODYNAMICS

538.3

12673 ON ELECTROMAGNETIC RADIATION REACTION. A.Peres.
Bull. Res. Coun. Israel, Vol. 7F, No. 4, 171-4 (Dec., 1958).

The radiation field of a system of slowly moving charged particles is expanded into powers of (v/c), and the work performed against it by the particles is computed. The first approximation gives the dipole radiation, and the next one the electric quadrupole and magnetic dipole radiations.

538.3

12674 TRANSPORT EQUATION FOR THE SPECTRAL DENSITY OF A MULTIPLE-SCATTERED ELECTROMAGNETIC FIELD. D.S.Bugnolo.
J. appl. Phys., Vol. 31, No. 7, 1176-82 (July, 1960).

The use of a first Born approximation is open to question when the path length is greater than a mean free path in the scattering region. It is therefore of interest to develop a transport equation capable of predicting the spectral density for such cases. The general theory presented in this paper is applied to the case of multiple scattering by dielectric noise. It is independent of models for the dielectric fluctuations. A method of solution is developed for the case of forward scattering. The particular case of a monochromatic plane wave incident of a half-space is discussed in detail. The results are applied to a numerical example in the troposphere.

538.3

12675 ON THE MATRIX FORMULATION OF THE THEORY OF PARTIAL POLARIZATION IN TERMS OF OBSERVABLES. G.B.Parrent, Jr and P.Roman.
Nuovo Cimento, Vol. 15, No. 3, 370-88 (Feb. 1, 1960).

The coherency matrix of a quasi-monochromatic plane wave is deduced from a matrix representation of the analytic signal associated with the electric field. It is shown that if the radiation passes through a physical device, such as a compensator, absorber, rotator, or polarizer, the effect of this interaction can be fully described in terms of appropriately choosen operators which transform directly the coherency matrix. The complex degree of coherence is defined in terms of the operators mentioned above, and from this is deduced an expression characterizing the degree of polarization. It is shown that the quantity deduced in this manner is identical with that obtained from the more conventional definition. An experiment is described which can serve to measure the components of the correlation matrix.

538.3

12676 THE RADIATIVE CORRECTION TO THE MASS OF THE ELECTRON IN NONLINEAR ELECTRODYNAMICS. V.Yu.Urbakh.
Zh. eksper. teor.Fiz., Vol. 37, No. 1 (7), 295-6 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 208-9 (Jan., 1960).

Using the non-linear theory of a previous paper (Abstr. 1050 of 1959) the previous value of the classical field mass is amended, and a preliminary value of the radiative correction is given. W.A.Hepner

538.3

12677 CHERENKOV RADIATION OF A [POINT] MAGNETIC DIPOLE IN AN ANISOTROPIC [GYROTROPIC] MEDIUM. G.A.Begiashvili and É.V.Gedalin.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1939-40 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1379-80 (Dec., 1959).

538.3

12678 CHERENKOV EFFECT IN THE MOTION OF A CHARGE ABOVE A BOUNDARY BETWEEN TWO MEDIA. A.G.Sitenko and V.S.Tkalich.
Zh. tekh. Fiz., Vol. 29, No. 9, 1074-85 (Sept., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 9, 981-91 (March, 1960).

The problem of a point charge moving parallel to the plane boundary between two media of different dielectric constants and magnetic susceptibilities is considered. General equations for the electromagnetic fields produced are obtained, and from these an expression for the energy loss due to Cherenkov radiation is derived. The results are generalized to apply to the motion of a charged sheet moving parallel to the boundary. E.J.Squires

538.3 : 535.22

PROPOSED EXPERIMENT FOR THE INVESTIGATION OF AN ENERGY DEPENDENCE OF PHOTON VELOCITY IN VACUO.
See Abstr. 12467

538.3 : 537.534

12679 SEPARABLE DYNAMICAL SYSTEMS OF STAECKEL IN FLAT SPACE. G.Iwata.
Progr. theor. Phys., Vol. 19, No. 4, 369-74 (April, 1958).

For previous work, see Abstr. 6274 of 1957. To assist in the study of the orbits of a high-energy charged particle in an electromagnetic field, coordinate systems and respective potential functions are determined where the Hamilton—Jacobi equation of the particle is integrable by separation of variables.

538.3 : 537.534

12680 PERFECT IMAGING DYNAMICAL SYSTEMS. G.Iwata.
Progr. theor. Phys., Vol. 19, No. 4, 375-88 (April, 1958).

See also preceding abstract. Perfect imaging dynamical systems are classified from the view-point of particle optics and their properties are studied. Examples illustrating inversion, translation and rotation are given.

538.3

12681 UNSTEADY INCOMPRESSIBLE COUETTE FLOW IN A UNIFORM TRANSVERSE MAGNETIC FIELD. C.C.Mei.
Appl. sci. Res. A, Vol. 9, No. 4, 275-84 (1960).

The unsteady plane Couette flow of an incompressible, viscous and infinitely conducting fluid in a uniformly imposed transverse magnetic field is studied. The problem is solved in general in a series form by means of a finite Fourier transform, and explicit solutions for two special cases are worked out.

538.3

12682 THE VARIATIONAL FORMULATION OF THE MAGNETOHYDROSTATIC EQUATIONS. P.C.Kendall.
Astrophys. J., Vol. 131, No. 3, 681-3 (May, 1960).

It is shown explicitly that stationary values of the potential energy of a general hydromagnetic system correspond to all equilibrium states. This variational method is equivalent to solving the magnetohydrostatic equations in a general form.

538.3

12683 **THE PLANE FLOW OF AN INFINITELY CONDUCTING FLUID WITH ALMOST PARALLEL VELOCITY AND AGNETIC FIELD VECTORS.** M.N.Kogan.
okl. Akad. Nauk SSSR, Vol. 130, No. 2, 284-6 (Jan. 11, 1960). In ussian.

Steady two-dimensional flow of an incompressible perfectly onducting fluid round an insulating solid is considered. Both elocity and magnetic field tend to uniformity at infinity. If v and make a small angle ϵ with each other at infinity, then it is shown hat the solid is surrounded by a boundary layer within which both omponents of H are $O(\epsilon)$, whereas they are $O(1)$ outside. The oundary-layer thickness tends to 0 as $\epsilon \to 0$. The appropriate oundary-layer equations are formulated and formally solved.

O.Penrose

538.3

12684 **AN EXAMPLE OF ISENTROPIC STEADY FLOW IN THE MAGNETOHYDRODYNAMICS.** T.Taniuti.
rogr. theor. Phys., Vol. 19, No. 6, 749-50 (June, 1958).

The basic magnetohydrodynamic equations are solved for a pecialized case of two-dimensional flow and an infinitely conducting uid. In the particular case considered it is shown that a discontinuy surface occurs in the slow subsonic flow if the magnetic field is ufficiently large.

C.G.Morgan

538.3

12685 **RELATIVISTIC MAGNETOHYDRODYNAMICS.** K.Goto.
rogr. theor. Phys., Vol. 20, No. 1, 1-14 (July, 1958).

Starting with the relativistic Boltzmann transport equation, asic equations for relativistic magnetohydrodynamics of perfect nd imperfect gases are derived. Relativistic magnetohydrodynamcal generalizations of Kelvin's circulation theorem, Helmholtz's ortex theorem and Rankine—Hugoniot's shock relations for a imple gas are also given.

538.3

12686 **HYDROMAGNETIC STABILITY OF FLOW BETWEEN ROTATING CYLINDERS.** R.J.Donnelly and M.Ozima.
Phys. Rev. Letters, Vol. 4, No. 10, 497-8 (May 15, 1960).

The stability of Couette flow of mercury between coaxial stainess steel cylinders in an axial magnetic field is studied experimentally. With the outer cylinder stationary, the critical angular velocity for the inner cylinder is found to increase with magnetic ield. The results agree quantitatively with calculations given by Niblett (Abstr. 1598 of 1959) for insulating cylinders.

O.Penrose

538.3

12687 **THE STABILITY OF A GRAVITATING CYLINDER IN THE PRESENCE OF MAGNETIC FIELDS.**
F.C.Auluck and N.K.Nayyar.
Z. Astrophys., Vol. 50, No. 1, 7-13 (1960).

Considers an infinitely long gravitating cylinder of incompressible, inviscid and infinitely conducting fluid, in the presence of a magnetic field having both toroidal and poloidal components. The ield has a stabilizing influence on the cylinder, but the value of the oot-mean square magnetic field within the cylinder is higher than hat in the models considered by Chandrasekhar and Fermi (1953) and by Auluck and Kothari (1957).

538.3

12688 **REFLECTION AND REFRACTION OF HYDROMAGNETIC PLANE WAVES AT THE BOUNDARY OF TWO COMPRESSIBLE MEDIA.** P.K.Raju and Y.K.Verma.
Z. Astrophys., Vol. 50, No. 1, 29-34 (1960).

Considers an interface separating two semi-infinite homogeneous compressible, inviscid and infinitely conducting media, with a prevalent uniform magnetic field normal to the interface. It is found that, for an incident Alfven wave, one gets only Alfven waves on reflection and refraction. For an incident modified Alfven and acoustic wave, one gets modified waves on reflection and refraction, but no pure Alfven mode. These results follow explicitly from the amplitude relations, modifying thereby the conclusions arrived at by Simon (Abstr. 8377 of 1959).

538.3 : 523.1

12689 **THEORY OF FORCE-FREE MAGNETIC FIELDS.** E.Richter.
Z. Phys., Vol. 159, No. 2, 194-211 (1960). In German.

Force-free magnetic fields are defined by the equation rot H = $= \alpha$H. Making use of a moving Frenet coordinate system (t = tangential, n = normal, b = binormal unit vector), the following general features of these fields are found: (1) Grad $|H|$ is always parallel to the osculating plane of the H-lines. (2) If the lines of force are rectilinear within a finite region of space, the component of grad $|H|$ along H must be zero for a force-free field with rot $H \neq 0$. (3) The factor of proportionality $\alpha = \alpha$ (r) and $|H|$ can be calculated by means of two equations involving only the direction of H. For several models of force-free fields, the effect of symmetry assumptions on $\alpha = \alpha$ (r) is discussed using special coordinate systems. It is pointed out that a particle drift arises in magnetic fields with $\alpha \neq 0$.

538.3 : 539.12

VISIBLE RADIATION OF SYNCHROTRON-ACCELERATED ELECTRONS. See Abstr. 11142

ELECTROMAGNETIC WAVES AND OSCILLATIONS

538.56 : 621.371

12690 **A STUDY OF NATURAL ELECTROMAGNETIC PHENOMENA FOR SPACE NAVIGATION.**
R.G.Franklin and D.L.Birx.
Proc. Inst. Radio Engrs, Vol. 48, No. 4, 532-41 (April, 1960).

A study was made of the use of natural electromagnetic radiation in the space environment for navigational purposes. Radiations from the sun, stars, and interstellar space in both visible and r.f. portions of the spectrum and also cosmic rays were investigated. Emphasis is placed on the measurement of velocity in space utilizing the Doppler phenomenon. Equipment and techniques useful in deriving velocity information from Doppler shift measurements are described and figures for expected accuracy are derived. Other passive techniques having possible application to space navigation such as the measurement of total solar radiation and solar diameter are briefly discussed.

538.56 : 621.382.2

12691 **PARAMETRIC DIODE FIGURE OF MERIT AND OPTIMIZATION.** K.E.Mortenson.
J. appl. Phys., Vol. 31, No. 7. 1207-12 (July, 1960).

The noise figure and gain expressions for the diode parametric amplifier are presented and discussed which include the effects of diode losses. From these relationships, a new diode figure of merit is defined as follows: $f_D = a_n/4\pi a_0^2 C_0 R_D$, where a_n is the normalized Fourier coefficient of the time dependent (pumped) capacitance; C_0, the diode capacitance at the operating bias point; and R_D, the equivalent series diode resistance. It is shown that this figure of merit is directly applicable in comparing diodes of various types as well as in optimizing their respective design for low-noise amplifier use. Further, it is indicated how this figure of merit can be directly employed by the circuit designer to predict an amplifiers' noise figure performance including the effects of choice of bias, pump swing, and signal and idle frequency for a given diode. A complete evaluation of the proposed figure of merit is made for the abrupt junction diode by expressing f_D in terms of device design parameters and examining as a function of bias and base doping. It is concluded, if no constraints are considered, that the maximum value of f_D is obtained for a bias approximately equal to half the breakdown voltage with full pump swing and that f_D(max) increases with decreasing base doping from 10^{18} to 3×10^{15} atoms/cm^3. It is further concluded that the maximum possible value of a_1/a_0^2 for the inverse square root of voltage capacitance law is approximately 0.557 such that the greatest value f_D(max) can attain is 20% of f_c, the diode cutoff frequency. Some possible limitations on this evaluation are discussed including the effects of diode deviation from model, pump power or diode dissipation restrictions, nonsinusoidal pumping waveform, and ambient temperature.

538.56 : 621.382.23

12692 **JUNCTION-DIODE AMPLIFIERS.** A.Uhlir, Jr.
Sci. American, Vol. 200, No. 6, 118-20, 123-4, 126-7, 129 (June, 1959).

A general article on the mechanism and use of the silicon junction diode. Attention is also paid to its use in preference to masers and transistors for low-noise amplification.

538.56 : 621.373.44

12693 PULSED FERRIMAGNETIC MICROWAVE GENERATOR.

B.J.Elliott, T.Schaug-Pettersen and H.J.Shaw.

J.appl. Phys., Suppl. to Vol. 31, No. 5, 400S-401S (May, 1960).

The idea of making a solid-state generator using a ferrimagnetic material to convert energy from a pulsed d.c. magnetic field into microwave radiation has been studied by several workers. Recent theoretical studies have disclosed serious basic problems for such devices. This paper describes initial experiments on a device which avoids the principle difficulties. It uses an r.f. input signal together with a pulsed d.c. magnetic field to generate microwave pulses at a frequency higher than the input frequency. An input signal at 2.4 kMc/s and a pulsed magnetic field of 150 gauss were used to generate a pulsed output signal at 2.8 kMc/s.

538.56 : 550.3

12694 ON THE ELECTROMAGNETIC RESPONSE OF A CONDUCTING SPHERE TO A DIPOLE FIELD.

J.R.Wait.

Geophysics, Vol. 25, No. 3, 649-58 (June, 1960).

The electromagnetic coupling between an electric and magnetic dipole in the presence of a spherical ore body is discussed. It is shown that both electric and magnetic modes must be considered even though all dimensions are small compared to the wave length. The results have application to a geophysical prospecting scheme where the exciting fields are set up by a straight insulating wire grounded at its end points and the secondary fields are detected by an ungrounded closed wire loop.

538.56

12695 CONTRIBUTION TO THE STUDY OF DIFFRACTION OF ELECTROMAGNETIC WAVES BY SPHERES.

J.Mevel.

Ann. Phys. (Paris), Ser. 13, Vol. 5, No. 3-4, 265-320 (March-April, 1960). In French.

Thesis, containing a thorough presentation of theoretical methods (of Stratton, Debye, Mie etc.) available for calculating diffraction fields of a single sphere, as well as of a pair of spheres. The scattering cross-section and the phase distribution are computed for conducting and for dielectric spheres. The experimental method for field measurement and the apparatus are described; the results are displayed and discussed; also measurements of scattering intensity by ellipsoids, cubes, etc., are included. J.K.Skwirzynski

538.56 : 534.26

12696 THE SOMMERFELD INTEGRAL AND THE SOLUTION OF DIFFRACTION PROBLEMS FOR WEDGE-SHAPED REGIONS.

G.D.Malyughinetz.

Ann. Phys. (Leipzig), Vol. 6, No. 1-2, 107-12 (1960). In German.

Survey of several papers by the author, and by others, on the derivation of inversion formulae for the Sommerfeld integral and their applications. W.A.Hepner

538.56 : 621.391.812.623

12697 DIFFRACTION BY SMOOTH CONICAL OBSTACLES.

H.E.J.Neugebauer and M.P.Bachynski.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 4, 317-29 (July-Aug., 1960).

Expressions obtained earlier [Abstr. 6393B of 1958; Proc. Inst. Radio Engrs, Vol. 46, 1619 (1958) and Abstr. 1778B of 1959; I.R.E. Trans Antennas and Propagation, Vol. AP-6, 341 (1958)] for the calculation of diffraction due to conducting obstacles with smooth cylindrical surfaces, are generalized to oblique incidence and to surfaces of conical shape. The derivation is based on a generalized concept of the Green's function and on the use of corrective factors that take the same place as corrections introduced by other authors into the theory of diffraction by apertures. The final expressions for conical obstacles and oblique incidence are very similar to those for cylindrical obstacles. The results are compared with scale model measurements.

538.56 : 621.372

12698 TOTAL ELECTROMAGNETIC CROSS SECTION OF IMPERFECTLY CONDUCTING CYLINDERS.

E.S.Cassedy and J.Fainberg.

J. appl. Phys., Vol. 31, No. 4, 739-40 (April, 1960).

The scattering amplitude vector which occurs in the formula for the total scattering cross-section of a perfectly conducting body, on which plane waves are incident, is stationary with respect to small changes in the induced current distribution. The cross-section of a cylinder whose length is comparable to, and whose diameter is small compared with, the wavelength is evaluated using this property from a guessed current distribution. The result obtained agrees well with measured values. G.D.Sims

538.56 : 621.391.812.623

12699 PROPAGATION AT OBLIQUE INCIDENCE OVER CYLINDRICAL OBSTACLES.

M.P.Bachynski.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 4, 311-15 (July-Aug., 1960).

Investigations of propagation of short electromagnetic waves at oblique incidence over smooth, perfectly conducting cylindrical obstacles are described. It is shown that the effect of oblique incidence can be considered as a change in the effective radius of curvature of the diffracting obstacle. The power in the shadow region of a cylindrical obstacle decreases with angle of obliqueness for horizontally polarized waves and can decrease, remain constant, or increase with angle of obliqueness for vertically polarized waves depending on the geometry of the propagation link. In all cases, vertical polarization gives a stronger field in the shadow region than horizontal polarization. In addition, it is shown that the diffracted field behind an obstruction of uniform radius of curvature is the same as that behind an obstacle of uniformly varying radius of curvature, provided the effective radius is the same.

538.56 : 621.391.812.624

12700 THE SPECTRUM OF X-BAND RADIATION BACK-SCATTERED FROM THE SEA SURFACE.

B.L.Hicks, N.Knable, J.J.Kovaly, G.S.Newell, J.P.Ruina and C.W.Sherwin.

J. geophys. Res., Vol. 65, No. 3, 825-37 (March, 1960).

A coherent radar was used to measure the "sea clutter" or backscattering of X-band electromagnetic energy from the sea surface. More than 200 recorded samples of clutter were analysed to give power spectra of the clutter. Each spectrum was displayed as a function of frequency and of position on the water surface and was also averaged to give the mean spectrum of patches 3750 feet long. Five of the samples showed an anomalous downwind displacement of the clutter by as much as 7 knots. The displays indicate again, as in earlier measurements, that the upwind edge of the clutter spectrum is smooth for all wind speeds observed, but that the downwind edge, for sea state 3 or above, is broadened in an irregular fashion as a function of range. This irregular broadening implies a considerable variability, from patch to patch, in the downwind side of the probability distribution of velocity of scatterers on the sea surface. The width at half-power of a mean spectrum is proportional, for reasonable assumptions, to the width at half-maximum of the probability distribution of scatterer velocities. The variation of the latter width, Δ_0, with sea state can be represented by the equation (expressed in consistent units) $\Delta_0 = 11H_{1/3}/T_m$, where the numerical factor is dimensionless, $H_{1/3}$ is the significant wave height, and T_m is the period corresponding to the maximum of the energy spectrum for the water waves themselves when this spectrum is plotted as a function of frequency. This equation fits the experimental data within about 10% for bandwidths in the range of 2 to 5 knots (64 to 160 c/s) and wind speeds in the range of 8 to 19 knots. The bandwidth of the clutter is found to be approximately proportional to the wind speed. The relationships of clutter bandwidths to wave and whitecap velocities, radar depression angle, and wind direction are also discussed.

538.56 : 621.396.674.3

12701 THE HALF-WAVE CYLINDRICAL ANTENNA IN A DISSIPATIVE MEDIUM: CURRENT AND IMPEDANCE.

R.King and C.W.Harrison.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 4, 365-80 (July-Aug., 1960).

An integral equation for the distribution of current along a cylindrical aerial in a conducting dielectric is derived. It is shown that the boundary conditions for an aerial in such a medium are formally the same as for an aerial in free space. The equation is solved for the current I and the driving-point impedance Z by means of a technique that achieves sufficiently high accuracy in the leading terms of an iteration procedure so that the higher-order terms do not need to be evaluated. Moreover, these leading terms consist only of trigonometric functions with complex coefficients. The electromagnetic field in the infinite dissipative medium may be computed relatively easily since the current in the aerial is express in such simple terms. A numerical analysis is made to determine the properties of an aerial with an electrical length of one-half wave length in the medium with conductivity σ and relative dielectric constant ϵ. Universal curves are given of $I/\sqrt{\epsilon_r}$ with $\sigma/\omega\epsilon_0\epsilon_r$ as the parameter and of $Z\sqrt{\epsilon_r}$ with $\sigma/\omega\epsilon_0\epsilon_r$ as the variable in the range $0 \leq \sigma/\omega\epsilon_0\epsilon_r \leq 0.4$. A table of numerical values of the impedance is given for media such as an isotropic ionosphere, dry salt, dry earth wet earth, and lake water.

538.56 : 621.372.852.22

12702 BROADBAND RECIPROCAL FERRITE PHASE SHIFTERS.

T.D.Geiszler and R.A.Henschke.

. appl. Phys., Suppl. to Vol. 31, No. 5, 174S-175S (May, 1960).

Broadband ferrite phase shifters were constructed in an X band aveguide by locating wide ferrite slabs along the centre of the broad aveguide wall and applying a longitudinal magnetic field. The bandidth of these phase shifters was optimized through proper selection ferrite dimensions and the amount of dielectric loading or by an opropriate choice of guiding structure. The relative phase shift otained from broadband configurations was found to vary in an almost linear fashion with the applied field when the ferrite was magetically saturated.

538.56

12703 PROPAGATION OF ELECTROMAGNETIC WAVES THROUGH A WAVEGUIDE FILLED WITH PLASMA.

.E.Golant and A.P.Zhilinskii.

h. tekh. Fiz., Vol. 30, No. 1, 15-24 (Jan., 1960). In Russian.

A mathematical treatment based on a perturbation expansion n powers of the conductivity of the plasma, carried to the second rder. Expressions are given for the damping and the phase shift ue to a non-uniform plasma, for a travelling wave, in terms of ntegrals over the cross-section of the waveguide. The case when he plasma only fills part of the waveguide, being contained by a ielectric envelope, is also covered by the analysis. The results of umerical calculations for a cylindrically symmetrical case are resented graphically. O.Penrose

538.56 : 550.3 : 621.391.8

12704 PROPAGATION OF ELECTROMAGNETIC PULSES IN A HOMOGENEOUS CONDUCTING EARTH.

J.R.Wait.

ppl. sci. Res. B, Vol. 8, No. 3, 213-53 (1960).

A general analysis for the electromagnetic response of conducing media due to pulse excitation is presented. The treatment is ased on the Laplace transform theory. First, a survey of the field s made and the limitations and scope of the previous work are ointed out. The theory of propagation of a plane-wave pulse in a onducting and homogeneous medium of infinite extent is then eviewed. The form of these results enable one to evaluate the elative importance of the conductivity and the dielectric constant. t is indicated, for sufficiently large times in the transient response, hat displacement currents may be safely neglected for sea water nd for most geological media. On this assumption, the waveform f the electric field in a conducting medium is illustrated for the ase where the source is an electric dipole energized by a step-unction current. Results are also presented for exponential and ell-shaped source functions. The pulse shape of the field compoents is profoundly modified as they propagate through the medium. t is suggested that this property may be utilized in measuring istances in the earth's crust. The more difficult problem of proagation in non-infinite conducting media is also considered. To ccount for the presence of the interface in a conducting half-space i.e. homogeneous flat ground), a rather involved analytical expresion for the transient fields is required. Certain special cases, uch as a horizontal electric dipole at the interface, are illustrated y numerical results. The transient excitation of a wire loop lying n the surface of a homogeneous ground is also considered. Transient coupling between pairs of parallel insulated wires grounded t their end points is treated as an extension of the earlier results.

538.56

12705 ELECTROMAGNETIC WAVES IN A MEDIUM WITH A CONTINUOUS ENERGY SPECTRUM. I.

V.S.Mashkevich.

h. eksper. teor. Fiz., Vol. 38, No. 3, 906-11 (March, 1960). In ussian.

The dependence of the polarization vector on the electric field trength was established for a medium possessing a continuous nergy spectrum. An integral expression defining polarizability as derived. Dispersion relations between the Hermitian and nonermitian parts of "polarizability kernel" are deduced.

538.56

12706 MAGNETOIONIC MODE COUPLING AT HIGH FREQUENCIES.

M.H.Cohen.

strophys. J., Vol. 131, No. 3, 664-8 (May, 1960).

The theory of magnetoionic mode coupling is extended to the ase in which the superposed magnetic field varies in amplitude and irection. Calculations are limited to the case X, Y, Z $\ll 1$ and to he case of a medium stratified in planes parallel to the wave front. n the quasi-longitudinal (QL) case, there is a "transitional" frequency, f_t, such that, when $f \ll f_t$, the modes are weakly coupled and the ordinary magnetoionic theory prevails; when $f \ll f_t$, there is strong coupling, and the wave propagates as if the magnetic field were absent. The QL transitional frequency is given by $f_t = 3 \times 10^{-3}$ NS, where N is electron density (cm^{-3}) and S is the scale of the magnetic field (cm). In the ionosphere and in interplanetary and interstellar regions, f_t is estimated to be 10^{12}–10^{14} c/s; thus the magnetoionic modes at radio frequencies are always weakly coupled in QL regions. In quasi-transverse (QT) regions the coupling may be much stronger because the characteristic polarizations change rapidly with θ. The QT transitional frequency is given by $f_t^4 = 10^{17}$ NSB^3, and the modes are weakly or strongly coupled according to whether $f^4 \ll f_t^4$ or $f^4 \gg f_t^4$. Estimates of f_t are of the order of tens of megacycles (ionosphere) and 10^4–10^6 c/s (interstellar and interplanetary regions). A circularly polarized wave has its sense of rotation reversed when propagating through a QT region, provided that the coupling is weak there. If the coupling is strong, the polarization is constant across the QT region. This mechanism might explain the commonly observed polarization reversal for the wide-band solar microwave bursts. This wide-band radiation propagates through a QT region above a sunspot, and at the earth the sense of rotation reverses at the QT transitional frequency. The possibility that the ionosphere and the interplanetary gas can interfere with the sense of rotation of solar radio bursts is also examined, in terms of coupling in the QT regions. Some other special situations that might arise in QT regions are briefly considered. These include the production of linear polarization, effects on differential absorption of the two magnetoionic modes, and differences in polarization that might result when either the source or the observer is in the QT region.

538.56 : 537.56

12707 GYRORESONANCE ABSORPTION OF ELECTROMAGNETIC WAVES IN A PLASMA.

B.N.Gershman.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 912-24 (March, 1960). In Russian.

Absorption of normal waves in a homogeneous, magnetoactive plasma is determined with allowance for thermal motion of electrons in a frequency range lying near the gyrofrequency and multiple frequencies. Collisions, as well as the absorption mechanism peculiar to the plasma, are taken into account.

538.56 : 537.56

12708 GROWTH OF ELECTROMAGNETIC WAVES IN A PLASMA MOVING IN A NONDISPERSIVE DIELECTRIC IN A CONSTANT MAGNETIC FIELD.

G.G.Getmantsev and V.O.Rapoport.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1205-11 (April, 1960). In Russian.

A dispersion equation was obtained which describes the propagation of plane electromagnetic waves in a plasma beam moving in a stationary plasma along the lines of force of a constant and homo geneous magnetic field. The attenuation (or growth) coefficients of the waves as a function of time were found for a rarefied plasma moving along the magnetic field through a nondispersive dielectric.

538.56

12709 DISPERSION AT VERY LARGE DENSITIES AND TEMPERATURES OF THE MEDIUM.

G.S.Saakyan.

Zh. eksper. teor.Fiz., Vol. 38, No. 3, 843-9 (March, 1960). In Russian.

The dispersion properties of a medium are investigated at high densities and temperatures, that is, under conditions which may exist in the inner regions of irregular stars (white superdwarfs). Single-photon annihilation and electron-pair creations occur at electron densities $N_e \geq 10^{32}\ cm^{-3}$. At frequencies satisfying a certain inequality scattering of electromagnetic waves is not due to electrons but to nucleons. At such frequencies and densities the refractive index is approximately $n \approx 1 + 1.05 \times 10^{-41} N$, where N is the neutron density. Hard Cherenkov radiation may occur in a medium of the discussed type. The energy of the Cherenkov quanta satisfies another inequality.

538.56 : 621.391.812.624

12710 ON THE QUESTION OF MULTIPLE SCATTERING IN THE TROPOSPHERE.

D.S.Bugnolo.

J. geophys. Res., Vol. 65, No. 3, 879-84 (March, 1960).

A criterion is developed to serve as a measure of multiple scattering in the troposphere as a result of dielectric noise. The question to be answered is: what is the probability that any ray of the incident field will be scattered at least twice in a distance R? This useful criterion can serve as a measure of reliability for the usual single-scatter approximations. It is developed in detail for an arbitrary dielectric noise and is applied to a number of special cases. The results indicate that the multiple-scattering effects should be of importance in the microwave spectrum.

538.56 : 621.391.812.63

12711 RELATION OF TURBULENCE THEORY TO IONOSPHERIC SCATTER PROPAGATION EXPERIMENTS.

A.D.Wheelon.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 4, 301-9 (July-Aug., 1960).

Attempts to relate turbulence theories to radio measurements on v.h.f. ionospheric forward scatter circuits. To this end, the single scattering description of the electromagnetic response of electron density regularities and the corresponding transmission expression are evaluated. Statistical distributions of signal levels are found to agree with a scattering model. The several theories for turbulent mixing of the electron density are then summarized. A turbulence mixing model is compared favourably with experimental data on absolute signal levels and their diurnal and seasonal variations. Scattering heights in the ionosphere responsible for the signals are also consistent with these theories. Frequency and disturbance dependence scaling laws are compared briefly with the data. The scatter signal behaviour during sudden ionospheric disturbances is also explained. No attempt is made to compare meteoric and turbulence scatter contributions to the measured quantities in this paper. 32 references.

538.56 : 621.391.822

12712 MEASUREMENTS OF THE SPECTRUM OF RADIO NOISE FROM 50 TO 100 CYCLES PER SECOND.

M.Balser and C.A.Wagner.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 4, 415-18 (July-Aug., 1960).

Experimental spectra of radio noise in the band of about 50 to 100 c/s were obtained by means of digital processing. Due to the long integration times which were used, the statistical uncertainty in the estimates of power was reduced to about 3% (0.13 dB). It was hoped in this way to observe maximums in the spectrum due to excitation of higher resonant modes of the earth—ionosphere cavity (for the accuracy of these data, such peaks should be observed if the Q of the cavity were 10 or greater at these frequencies). No statistically significant evidence of these cavity effects was found.

538.56

12713 ON THE EFFECT OF A MAGNETIC FIELD UPON EXTREMELY LOW FREQUENCY (ELF) WAVE PACKETS.

O.Holter,

Astrophys. Norveg., Vol. 6, No. 12, 131-45 (Jan., 1960).

An expression on a form analogous to the Appleton-Hartree formula for the refractive index is evaluated when the plasma has different components. At extremely low frequencies the best approximation to the exact formula is the Q.T.-approximation, and not the Q.L.-approximation as in the Appleton-Hartree theory. When it is possible to calculate the path of the extraordinary wave-packets in the Q.T.-approximation, it results that the path coincides with the magnetic lines of force. Thus, the more the region where this approximation is valid increases (by lowering the frequency of the wave), the more the packets are guided along the lines of force. No such guiding is present in the ordinary mode. The theory may be applied to whistler propagation.

538.56 : 621.391.812.63

12714 ON THE PROPAGATION OF E.L.F. RADIO WAVES AND THE INFLUENCE OF A NONHOMOGENEOUS IONOSPHERE.

J.R.Wait.

J. geophys. Res., Vol. 65, No. 2, 597-600 (Feb., 1960).

The model assumed consists of a spherical earth surrounded by a concentric ionosphere whose electron density increases exponentially with height. This elaboration of the usual homogeneous model appears to explain the observed attenuation for terrestrial propagation as a function of frequency in the range 100 c/s to 1 kc/s.

538.56 : 621.391.8

12715 MODE THEORY AND THE PROPAGATION OF E.L.F. [EXTREMELY LOW FREQUENCY] RADIO WAVES.

J.R.Wait.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 4, 387-404 (July-Aug., 1960).

The mode theory of propagation of electromagnetic waves at extremely low frequencies (1.0 to 3000 c/s) is treated. Starting with the representation of the field as a sum of modes, approximate formulae are presented for the attenuation and phase constants. Certain alternate representations of the individual modes are mentioned. These are used as a basis for describing the physical behaviour of the field at large distances from the source, particularly near the antipode of the source. At the shorter distances, where the range is comparable to the wavelength, the spherical-earth mode series is best transformed to a series involving cylindrical wave functions. This latter form is used to evaluate the near field behaviour of the various field components. The effect of the earth's magnetic field is also evaluated using a quasi-longitudinal approximation. In general, it is indicated that, if the gyrofrequency is less than the effective value of the collision frequency, the presence of the earth's magnetic field may be neglected for e.l.f. When this condition is not met, the attenuation may be increased somewhat. The influence of an inhomogeneous ionosphere is also briefly considered and, finally, the propagation of e.l.f. pulses is treated. It is suggested that certain observed characteristics of e.l.f. waveforms may be attributed to the inclination of the current channel in the lightning discharge.

538.56 : 621.391.812.3

12716 DAYTIME ATTENUATION RATES IN THE VERY LOW FREQUENCY BAND USING ATMOSPHERICS.

W.L.Taylor.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 4, 349-55 (July-Aug., 1960).

Daytime attenuation characteristics have been computed by comparing the amplitude spectra of atmospheric waveforms recorded at four widely separated stations. The results of these attenuation measurements are presented for the band of frequencies from 3 to 30 kc/s and involving distances of 1000 to 10 000 km. It was found from these data that attenuation was about 7 to 9 dB per 1000 km at 6 kc/s and decreases to about 1 to 3 dB per 1000 km at frequencies greater than 10 kc/s. The difference in attenuation rate of west-to-east propagation relative to east-to-west propagation was about 3 dB per 1000 km less for frequencies lower than 8 kc/s and about 1 dB per 1000 km less from frequencies higher than 10 kc/s.

537.56 : 621.391.812.32

12717 ANOMALIES IN THE ABSORPTION OF RADIO WAVES BY ATMOSPHERIC GASES.

A.W.Straiton and C.W.Tolbert.

Proc. Inst. Radio Engrs, Vol. 48, No. 5, 898-903 (May, 1960).

Summarizes recent measurements of the attenuation of radio waves by atmospheric gases and compares the measured losses with those predicted by Van Vleck. Reasonably good agreement has been noted between the predicted and measured losses for oxygen, but the measured loss for water vapour is considerably in excess of that predicted. Various factors which may influence this discrepancy are discussed.

NUCLEAR AND ATOMIC PHYSICS

539

12718 PRESENT STATUS OF THE LOW ENERGY NUCLEAR PHYSICS. V.F.Weisskopf.
ppl. Progr. theor. Phys., No. 11, 52-68(1959).

Note of a lecture given at the Institute for Nuclear Study, Tokyo iversity, on Sept. 7, 1959. The subjects covered include nuclear rces, nuclear matter, deformed nuclei, and the theory of nuclear actions.

APPARATUS . PARTICLE DETECTORS

539.1.07 : 621-52 : 621.374.3

12719 NUCLEAR ELECTRONICS.
[L'électronique nucléaire]. I.
ienna: International Atomic Energy Agency (1959) xii + 452 pp.

Being Volume I of the Proceedings of the International Symposium Nuclear Electronics held in Paris in September 1958 and organized the Société Française des Radioélectriciens. The first five essions are reported under the following titles: (i) Scintillation adiation detectors (ii) Radiation detectors using ionizing methods, nd γ-ray spectrometers (iii) Pulse technique: fast electronics v) Pulse technique: classical electronics (v) Reactor control: easurements. For abstracts of selected papers see succeeding sues of Science Abstracts.

539.1.07 : 621-52 : 621.374.3

12720 NUCLEAR ELECTRONICS.
[L'électronique nucléaire]. II.
ienna: International Atomic Energy Agency (1959) viii + 378 pp.

Being Volume II of the Proceedings of the International ymposium on Nuclear Electronics held in Paris in September 1958 nd organized by the Société Française des Radioélectriciens. The st four sessions are reported under the following titles: (vi) Re- ctor control: simulation (vii) Equipment for prospection and otection (viii) Centralization and exploitation of results (ix) Tran- torized equipment, standardization, and components. For ab- racts of selected papers see succeeding issues of Science Abstracts.

539.1.07

12721 HELIUM—BUTANE GAS MIXTURES AS FILLINGS FOR GEIGER—MULLER TUBES. V.Moses and J.F.Fowler.
ature (London), Vol. 186, 538-9 (May 14, 1960).

Gives the results of detailed tests on various gas mixtures with ata on plateau slopes and lengths, operating voltages, etc. for a cott end-window gas-flow counter and for a Nuclear-Chicago D-47 ounter. These tubes are particularly applicable to chromatogram canners and sample changing devices. J.D.Craggs

539.1.07

12722 CHARACTERISTIC PARAMETERS OF GAS-TUBE PROPORTIONAL COUNTERS. I. METHANE, IETHANE—ARGON AND ETHANOL—ARGON COUNTERS.
.W.Kiser.
ppl. sci. Res. B, Vol. 8, No. 3, 183-200 (1960).

The gas multiplication factor A was determined in cylindrical ounters at specific counter wire voltages and varied pressures, ire radii and counter shell radii for methane and various methane—rgon mixtures, as used in proportional counters. It is seen that ne Rose—Korff and the Curran—Craggs modified Rose—Korff theory o not agree with the experimental results. Use of the Diethorn xpression is made in presenting the results in terms of two para- neters $\overline{\Delta V}$ and $\overline{K}$, characteristic of the gas filling. The meaning nd values of $\overline{\Delta V}$ and $\overline{K}$ are discussed, and the results of van Duuren nd Sizoo (Abstr. 8401 of 1959) for an ethanol—argon mixture are einterpreted in terms of these characteristic parameters.

539.1.07

12723 INSTRUMENTATION IN AIRCRAFT FOR RADIATION MEASUREMENTS. F.J.Davies and P.W.Reinhardt.
uclear Sci. Engng, Vol. 2, No. 6, 713-27 (Nov., 1957).

A description of the six-crystal NaI scintillation gamma-ray etector used by the U.S. Geological Survey in making radiation urveys through the United States and Alaska. It is shown that the variation of radiation with height above ground in the neighbourhood of 500 ft can be adequately expressed by use of a buildup factor which varies proportionately with height. Measurements of point and broad sources are shown to compare well with theory.

539.1.07

12724 HOW MUCH DO WAVE LENGTH SHIFTERS USED FOR CERENKOV COUNTERS SCINTILLATE?
G.Finocchiaro, R.Finzi and L.Mezzetti.
Nuovo Cimento, Vol. 15, No. 3, 317-22 (Feb. 1, 1960).

The increase in light output of liquid Cherenkov counters obtained by the addition of wavelength shifting substances (as suggested by many authors) has been studied. It is shown that most of the observed increase is due to scintillation and not to actual wavelength shifting. Crystalline sodium salycilate coating of the counter walls has also been used for the same purpose. Its average quantum efficiency is found to be relatively high but its practical use is limited by the fact that its reflectivity in the visible is lower than that of MgO.

539.1.07 : 621.387.4

12725 LARGE AREA GERMANIUM SURFACE-BARRIER COUNTERS.
F.J.Walter, J.W.T.Dabbs and L.D.Roberts.
Rev. sci. Instrum., Vol. 31, No. 7, 756-62 (July, 1960).

A description is given of a solid-state counter of good resolution, long term stability, and fast rise time which is suitable for heavy charged particles, for example, alpha particles and fission fragments. A simple theoretical model for the counter behaviour is presented which is found to describe the observed behaviour of the counter very well. The importance of germanium purity in connection with pulse height, rise time, and counter area is discussed. Counters with sensitive areas up to 5 cm^2 have been successfully used.

539.1.07 : 539.2 : 535.37

RESPONSE OF NaI(Tl) TO ENERGETIC HEAVY IONS.
See Abstr. 11788

539.1.07

12726 NEW GLASS DOSIMETER IS LESS ENERGY-DEPENDENT.
R.J.Ginther and J.H.Schulman.
Nucleonics, Vol. 18, No. 4, 92,95 (April, 1960).

Substitution of $Mg(PO_3)_2$ and $LiPO_3$ for the $Ba(PO_3)_2$ and KPO_3 in the radiophotoluminescent glass of approximate composition 25 $Ba(PO_3)_2$, 25 KPO_3, 50 $Al(PO_3)_3$ and 8 $AgPO_3$ parts by weight, gives a glass less absorbent for X-rays but with the same sensitivity to 1.2 MeV γ-rays. R.D.Smith

539.1.07

12727 DOSE AND DOSE MEASUREMENT WITH IONIZING RADIATION. R.Glocker.
Z. Phys., Vol. 158, No. 2, 145-50 (1960). In German.

An exact mathematical definition of dose is required. The average dose measured experimentally is only related to the dose at a point (differential dose) if electronic equilibrium exists and if the Bragg—Gray principle is satisfied. J.R.Mallard

539.1.07

12728 VELOCITY DEPENDENCE OF THE BUBBLE DENSITY FOR CHARGED PARTICLE TRACKS IN LIQUID HYDROGEN. V.P.Kenney.
Phys. Rev., Vol. 119, No. 1, 432-5 (July 1, 1960).

Bubble densities of tracks of 635 MeV/c protons and pions in a liquid hydrogen bubble chamber operated at 26.5°K and 62 p.s.i.g. were determined from measurements of the distribution in spacing of the individual bubbles The velocity dependence of the bubble density was obtained by fitting the bubble densities observed to the expression $m = A/\beta^b$ by the least-squares method, yielding the values A = 8.64 bubbles/cm, and exponent b = 1.935 ± 0.077. The constant A is a function of the temperature of the liquid hydrogen, varying ~ 30% per 0.1°K. If the number of bubbles per unit track length observed is correlated with the rate of delta-ray formation, it would appear that an energy of the order of 400 eV is necessary for bubble nucleation in liquid hydrogen.

539.1.07 : 536.48

HYDROGEN BUBBLE CHAMBER REFRIGERATION SYSTEM. See Abstr. 12540

539.1.07

12729 A METHOD TO DETERMINE THE CHARGE OF NUCLEI WITH NUCLEAR EMULSIONS. G.Alvial, L.Grimaldi, J.Riquelme, E.Silva and S.Stantic.
Nuovo Cimento, Vol. 15, No. 1, 25-30 (Jan. 1, 1960).

Gives experimental results on a method of determining the charge of either high and low energy nuclei with nuclear emulsions. Only the track thicknesses over a pre-fixed width are considered, obtained by measuring the thickness according to the method given by Occhialini and collaborators, and a criterion is determined to count this type of thickness which are probably caused by short δ-rays.

539.1.07 : 537.54

USE OF NUCLEAR EMULSIONS IN CONJUNCTION WITH PARTICLE ACCELERATORS. See Abstr. 12654

539.1.07 : 77

12730 THE TOTAL PHOTOGRAPHIC EFFECT OF ELECTRONS. GRANULATION AFTER EXPOSURE TO ELECTRONS. H.Frieser.
"Particle photography" Conference, Montreal, 1958 (see Abstr. 2261 of 1960), p. 30-3. In French.

A method of measuring the degree of granulation in a photographic plate is outlined, and the choice of the best parameters for this purpose investigated theoretically. S.J.St-Lorant

539.1.07 : 77

12731 THE DISTINCTION BETWEEN FOG DUE TO γ-RADIATION AND CHEMICAL FOG IN THE EMULSION. J.Bermond.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960), p.40-4. In French.

An attempt is made to obtain an improved discrimination between the background fog produced by weak γ-sources and the chemical fog introduced by the development by employing an almost neutral amidol developer and curtailing the developing time.
S.J.St-Lorant

539.1.07 : 77

12732 THE ACTION OF MEDIUM-ENERGY ELECTRONS ON PHOTOGRAPHIC EMULSION. L.M.Biberman and I.A.Fomina.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960), p.45-9. In French.

The relation between the degree of blackening of photographic emulsion and the intensity of a beam of electrons is studied. It is found that in the region of reciprocity failure the granulation depends on the interval between successive collisions of the electrons with the same grain of halide. At low electron intensities this interval exceeds the lifetime of the sensitive centres, whereas in the intermediate region the two periods are comparable, so that some collective action of the electrons is possible. The effects of the development mechanism are also discussed. S.J.St-Lorant

539.1.07 : 77

12733 THE PHOTOGRAPHIC ACTION OF BETA-RAYS. S.Kikuchi and Y.Oishi.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960), p. 50-6. In French.

A macroscopic, sensitometric study is made of six currently available nuclear and commercial photographic emulsions of Japanese manufacture. Electrons from a number of β-emitters, graded according to the maximum energy of the particles, are used as sources of granulation. The sensitometric curves obtained are compared with those obtained by exposure to light, and the results discussed in terms of current theories of latent image formation.
S.J.St-Lorant

539.1.07

12734 THE PREPARATION OF NUCLEAR EMULSIONS WITH AN INCREASED PERCENTAGE OF SILVER HALIDE IN GELATINE. W.Markocki.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960), p. 59-63. In French.

Describes a method of enhancing the silver halide content of nuclear emulsions relative to the gelatine, by coagulation of the halide with solutions of electrolytes and ethyl alcohol. The efficiency of the process as a function of the ambient pH is considered.
S.J.St-Lorant

539.1.07 : 77

12735 SOME FACTORS AFFECTING THE SENSITIVITY OF NUCLEAR EMULSIONS. J.Kubal.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 64-8. In French.

The influence of Cd and I ions on the properties and the sensitivity of special emulsions exposed to white light, α-particles and electrons is studied sensitometrically. Possible hypersensitization of the emulsion with a 2% solution of triethanolamine in the presence of other sensitizing agents is investigated. S.J.St-Lorant

539.1.07

12736 THE PREPARATION AND PROPERTIES OF ULTRA-FINE GRAIN EMULSIONS FOR NUCLEAR RESEARCH. N.A.Perfilov, E.I.Prokofyeva, N.R.Novikova, O.V.Lojkin, V.F.Darovkikh and G.F.Denissenko.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960), p. 69-78. In French.

The standardized experimental procedure used in the preparatio of special emulsions is described, together with hints on storage and hypersensitization. The variations in the stopping power, shrinkage properties and the sensitivity to light of such ultra-fine grain emulsions are discussed and the characteristic response of the emulsion to the passage of different particles evaluated. The theoretical relation between the grain density and the specific energy loss for a particle of given ionization is deduced from the data.
S.J.St-Lorant

539.1.07 : 77

12737 THE LABORATORY PRODUCTION OF A FINE-GRAIN EMULSION. A.J.Oliver.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960), p. 79-90. In French.

Investigates the relation between the distribution of the grain size of unprocessed silver bromide and the quantity of silver ions present in excess during the precipitation stage in the production of fine-grain emulsions. S.J.St-Lorant

539.1.07 : 77

12738 THE PREPARATION OF NUCLEAR EMULSIONS AND THE MECHANISM OF HYPERSENSITIZATION WITH TRIETHANOLAMINE. A.P.Jdanov, A.L.Kartujanski, V.N.Kuzmin, I.V.Ryjkova, P.I.Fedotov and L.I.Chour.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960), p.91-101. In French.

The increased sensitivity of emulsion achieved by treatment with triethanolamine (TEA) is studied as a function of the concentration of the hypersensitizing agent. It is shown that TEA not only enhances the sensitivity of the emulsion but also that it inhibits the fading of the latent image. The implications of this observation on the theory of the latent-image formation are discussed. To study the interactions of different particles with nuclei other than those of the emulsion, the possibility of introducing other materials in the form of suspensions into the emulsion is considered.
S.J.St-Lorant

539.1.07 : 77

12739 ULTRA-FINE GRAIN CHLORO-BROMIDE AND POLY-VINYL ALCOHOL EMULSIONS. J.Demers and P.Demer
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960), p. 102-5. In French.

The effect of small concentrations of chloride ions on the unifor grain properties is studied. It appears that the presence of Cl^- exerts a beneficial influence in emulsions based on polyvinyl alcohol
S.J.St-Lorant

539.1.07 : 77

12740 THE PREPARATION OF NUCLEAR EMULSIONS FROM DILUTE SOLUTIONS. A.Narath and G.Heimann.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960), p. 106-8. In French.

Investigates the consequences of employing dilute solutions in the precipitation stage and the removal of the excess water by chemical means, in the production of fine-grain emulsions.
S.J.St-Lorant

539.1.07

12741 THE CHARACTERISTICS OF FUJI TYPE ET-7A NUCLEAR EMULSIONS.

Imaeda, M.Kazuno, S.Fujisawa, Y.Koseki, A.Miyauchi and Y.Takao.
article photography" Conference. Montreal, 1958 (see Abstr. 2261
1960) p. 109-14. In French.

Describes the chemical composition, the size of the silver halide
ains, the density and the stopping power and the sensitivity of the
ulsion. S.J.St-Lorant

539.1.07

12742 STUDIES ON IMPROVEMENT OF THE MECHANICAL PROPERTIES AND THE STRUCTURE OF PHOTO-
APHIC FILMS FOR NUCLEAR RESEARCH.

M.Ouvarova and V.A.Myltseva.
'article photography" Conference. Montreal, 1958 (see Abstr. 2261
1960) p. 115-23. In French.

The mechanical properties and the nature and extent of the dis-
rtion of emulsion during processing were studied with a view to
taining criteria for the production of emulsion films in structural
uilibrium and without deformation of the macromolecules of the
latine support. S.J.St-Lorant

539.1.07

12743 INCREASED SENSITIVITY OF NUCLEAR PHOTOGRAPHIC EMULSIONS AT LOW TEMPERATURES
ODUCED BY HYPERSENSITIZATION.

S.Bogomolov, I.F.Razorenova, I.A.Rouditskaya and A.A.Sirotinskaya.
article photography" Conference. Montreal, 1958 (see Abstr. 2261
1960) p. 124-7. In French.

Russian type R NIKFI emulsions hypersensitized with triethano-
mine are capable of recording relativistic particles at high grain
nsities down to liquid-hydrogen temperatures. S.J.St-Lorant

539.1.07 : 77

12744 HYPERSENSITIZATION OF NUCLEAR PHOTOGRAPHIC EMULSIONS.

S.Bogomolov, I.A.Rouditskaya, I.F.Razorenova, A.A.Sirotinskaya
d E.P.Dobrossierdova.
'article photography" Conference. Montreal, 1958 (see Abstr. 2261
1960) p. 128-39. In French.

A comprehensive survey of the hypersensitizing action of tri-
hanolamine (TEA) on NIKFI, type R, nuclear emulsions. The
ethod of obtaining sensitized emulsions is described and the nature
the action of TEA, studied in connection with the treatment an
nulsion receives before exposure. Sensitization by triethanolamine,
iethylamine and two tertiary oxy-amines containing respectively
e and two hydroxyl groups is compared from the point of view of
ficiency governed by the molecular structure of the agent employed.
tentative explanation of the observed differences is given.
S.J.St-Lorant

539.1.07 : 77

12745 A STUDY OF CHEMICAL SENSITIZATION OF NUCLEAR EMULSIONS.

.Protass, J.A.Krakau and P.T.Sidorenkova.
'article photography" Conference. Montreal, 1958 (see Abstr.
61 of 1960) p. 140-4. In French.

The sensitizing action of a number of chemical complexes in
rticular those containing sulphur atoms and salts of gold, is
vestigated in nuclear emulsions exposed to ionizing radiation.
S.J.St-Lorant

539.1.07 : 77

12746 CHEMICAL SENSITIZATION OF NUCLEAR EMULSIONS WITH VARIOUS INORGANIC SALTS. F.Simon.

'article photography" Conference. Montreal, 1958 (see Abstr.
61 of 1960) p.145-50. In French.

Presents the sensitometric analysis of nuclear emulsions, to
ich various inorganic salts were added at the production stage, as
function of the duration, intensity and nature of the illumination.
S.J.St-Lorant

539.1.07

12747 MICROSCOPY OF THICK EMULSION FILMS.

H.Yagoda and M.B.Dickinson.
'article photography" Conference. Montreal, 1958 (see Abstr.
61 of 1960) p. 159-61. In French.

Discusses a method for mounting thick nuclear emulsions on
ass with a minimum of distortion after alcohol drying.
S.J.St-Lorant

539.1.07 : 77

12748 A NEW DEVELOPING DEVICE.

G.Bellettini, A.Manfredini and R.Sanna.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 162-6. In French.

Describes the construction of a processing device which reduces the thermal delay between the hot and cold stages to a minium. S.J.St-Lorant

539.1.07

12749 THE PHOTOGRAPHIC PROCESSING OF THICK FILMS OF NIKFI MATERIALS USED FOR NUCLEAR STUDIES.

V.M.Ouvarova, T.Krestovnikova, V.A.Myltseva and K.M.Romanovskaya.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 167-72. In French.

A description is given of a two-stage development process based on the Bristol—Brussels amidol formula modified by the addition of citric acid to maintain the pH of the solution at a predetermined value. Attention was paid to elimination of the dichroic fog and to reduction of the distortion to a minimum. S.J.St-Lorant

539.1.07

12750 HANDLING OF K5 EMULSIONS WITH THE BRUSSELS SEMI-AUTOMATIC PROCESSING PLANT.

A.Igiuni and G.Occhialini.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 173-9. In French.

A detailed description of the processing of K5 emulsions by the wet hot-storage method requiring the minimum of handling of the emulsions. A formulary of the recommended solutions is appended, and an outline of the necessary apparatus is given. S.J.St-Lorant

539.1.07

12751 THE MOUNTING AND DEVELOPMENT OF LARGE STACKS OF EMULSION PELLICLES. B.Judek.

"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 180-4. In French.

A resumé of methods suitable for processing nuclear emulsion pellicles exceeding 100 in^2 in area. S.J.St-Lorant

539.1.07

12752 THE FIXING OF NUCLEAR EMULSIONS.

D.Heughebaert and J.Heughebaert.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 185-90. In French.

Investigates the properties of three commonly employed fixing baths as a function of the extent of the undesirable side effects produced by each, namely corrosion and swelling resulting in distortion. It is concluded that the variation in the pH of the solutions at this stage is chiefly responsible for this. S.J.St-Lorant

539.1.07

12753 THE POSSIBILITY OF REALISING A WET HOT-STAGE IN DEVELOPMENT AT TWO TEMPERATURES.

J.Heughebaert, A.Igiuni and G.Occhialini. In French.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 191-3. In French.

A brief discussion of possible methods of avoiding excessive handling of emulsion films, which is required in the dry hot-stage processing technique. S.J.St-Lorant

539.1.07

12754 AUTOMATIC DEVELOPMENT AT ONE TEMPERATURE.

J.Demers and P.Demers.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 194-6. In French.

A fully automatic processing plant is described, with which small amounts of ultra-fine grain emulsion 700 μ thick were developed. The development takes place at $2^{\circ}C$, for 7 to 8 hours, giving grains 0.05 to 0.25 μ diameter in the interior of the emulsion and 0.3 to 0.4 μ at the surfaces. S.J.St-Lorant

539.1.07

12755 THE DEVELOPMENT OF NUCLEAR EMULSIONS LOADED WITH A METALLO-ORGANIC COMPLEX OF ETHYLENEDINITRILO-TETRA-ACETIC ACID (DEVELOPMENT AT THE "ISOELECTRIC" POINT). H.G.De Carvalho and A.G.Da Silva.

"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 197-9. In French.

It is shown that the swelling and the subsequent distortion of an emulsion are minimized by maintaining the emulsion at a pH of 4.2 throughout the processing. This is achieved by loading the emulsion with a complex-forming agent and using a developer based on the ferro-complex of ethylenedinitrilo-tetra-acetic acid (versene) in an acetate buffer. S.J.St-Lorant

539.1.07 : 77

12756 THE USE OF DIPHENYL IODONIUM NITRATE AS AN AID IN THE DEVELOPMENT OF EMULSIONS FOR NUCLEAR RESEARCH.

W.Markocki and E.Gizejowska.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 200-2. In French.

To achieve a reduction of fog without loss of sensitivity in nuclear and commercial emulsions the inhibitive properties of benztriazole, 5-methyl-7-oxy-1, 3, 4-triazainindolizine and diphenyl iodonium nitrate were studied. The first two reagents showed no improvement over added Br$^-$ ions, but in the last case considerable enhancement of the sensitivity to light of the commercial emulsions was observed. Preliminary results for nuclear emulsions indicate no loss of sensitivity at greatly reduced fog levels. S.J.St-Lorant

539.1.07

12757 SWELLING OF NUCLEAR EMULSIONS BY A TREATMENT WITH COLOPHANE RESIN.

J.Catala and J.Casanova.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 203-6. In French.

Presents a systematic study of the variables involved in the treatment of a dry emulsion with an alcoholic solution of colophane resin in order to regain the original thickness of the emulsion after processing. Some useful suggestions are given on how to obtain reproducible results. S.J.St-Lorant

539.1.07

12758 A STUDY OF UNIFORM DEVELOPMENT IN DEPTH OF NUCLEAR EMULSIONS.

I.Hauser.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 207-9. In French.

A method is described whereby uniform development throughout the entire depth of Agfa K2 emulsion films is obtained. Since this emulsion is not sensitive to minimum ionizing tracks a modification of the usual method of estimating the development gradient was devised. S.J.St-Lorant

539.1.07

12759 THE KINETICS OF THE DEVELOPMENT OF MINIMUM IONIZING TRACKS IN NUCLEAR EMULSIONS.

H.G.De Carvalho and A.G.Da Silva.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 210-14. In French.

The extent to which a number of established laws governing the process of grain formation in the development of ordinary photographic emulsions can be applied to Ilford G5 nuclear emulsions is investigated. The speed of development and its relation to the temperature of the developer, and the effect of the nature and concentration of the developer are discussed. Within certain limitations the same laws are found to hold. S.J.St-Lorant

539.1.07

12760 THE THEORY OF DIFFUSION IN THE DEVELOPMENT OF THICK EMULSION PELLICLES.

P.Demers.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 215-17. In French.

The three stages in the development of nuclear emulsions are described in terms of one-dimensional diffusion equations with simplified boundary conditions. S.J.St-Lorant

539.1.07

12761 THE GRAIN DIAMETER AND THE GRAIN DENSITY OF ILFORD K5 AND L4 EMULSIONS.

R.C.Kumar.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 221-4. In French.

The mean diameter of undeveloped K5 and L4 emulsion grains was found to be $0.210 \pm 0.007\ \mu$ and $0.134 \pm 0.004\ \mu$ respectively. It was found that the grain density of electron tracks at plateau ionization is comparable with that found for G5 provided that no fading has taken place. S.J.St-Lorant

539.1.07

12762 THE GRAIN DIAMETER AND THE SENSITIVITY OF NUCLEAR EMULSIONS.

H.G.De Carvalho and A.G.Da Silva.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 225-7. In French.

A simple method of measuring the grain diameter of G5 emulsions is described, and the relation between the grain diameter and the track density deduced. S.J.St-Lorant

539.1.07 : 77

12763 THE DISTRIBUTION OF THE PARTICLE LATENT IMAGE.

R.Schmitt.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 237-42. In French.

A study of the Cabannes—Hoffman effect using several types of nuclear emulsions developed in a number of different developers. Exposures to α- and β-radiation and to light flashes of variable duration were employed. S.J.St-Lorant

539.1.07 : 77

12764 THE LATENT IMAGE IN NUCLEAR EMULSIONS DUE TO LIGHT AND PARTICLES, AT LOW TEMPERATURES

M.Debeauvais-Wack.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 243-5. In French.

The sensitivity of G5 and C2 emulsions, impregnated with a number of halogen acceptors was measured as a function of temperature, but no general diminution of the sensitivity was observed. The sensitometric curves obtained for white light and with exposures to electrons show the same gross features in C2 and K5 emulsions; in G5 emulsion a relative displacement of the maxima was noted. S J.St-Lorant

539.1.07

12765 PROPERTIES OF EMULSION MIXTURES.

M.Réné and G.Vanderhaeghe.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 246. In French.

It is verified that the characteristics curves of mixtures of G5 and G0 emulsions are linear combinations of the curves for pure emulsions. From these relations possible separation between particles of adjacent charges is deduced. S.J.St-Lorant

539.1.07

12766 THE SEPARATION OF SHORT-RANGE DEUTERONS AN PROTONS IN NUCLEAR EMULSIONS.

J.Catala, F.Senent and R.Font.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 251-4. In French.

Describes further experimental evidence on the usefulness of previously described methods (Abstr. 13549 of 1959), which discriminate between protons and deuterons (and other particles) in the last millimetres of their tracks. S.J.St-Lorant

539.1.07

12767 THE SEPARATION OF LOW-ENERGY DEUTERONS FROM PROTONS IN ULTRA-FINE GRAIN EMULSIONS.

J.J.Grant, H.A.Medicus, J.Demers and P.Demers.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 255-6. In French.

Complete separation between deuterons and protons is possible in ultra-fine grain emulsions by simple grain counting in the last 40μ of the track. S.J.St-Lorant

539.1.07

12768 NEW RESULTS ON MEASUREMENT OF IONIZATION IN NUCLEAR EMULSIONS.

L.Ciuffolotti and G.Tomasini.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 257-9. In French.

A brief resume of some results on ionization properties of the K5 and G5 emulsions, especially the frequency distribution of the gap lengths and the measurement of mass by the residual range v. ionization technique. S.J.St-Lorant

539.1.07

12769 THE PLATEAU-TO-MINIMUM IONIZATION RATIO IN MODERATELY DEVELOPED K5 EMULSIONS.

R.H.W.Johnston and D.J.Prowse.
"Particle photography" Conference. Montreal, 1958 (see Abstr.

1 of 1960) p. 260-3. In French.
The ratio was found to be 1.12 ± 0.01, using 500-1200 MeV/c
ns and 100 MeV electrons. S.J.St-Lorant

539.1.07

12770 THE APPLICATION OF PHOTOGRAPHIC EMULSIONS TO MEASUREMENTS OF GAPS IN PARTICLE TRACKS.
\der with the collaboration of M.P.Cabannes.
ırticle photography" Conference. Montreal, 1958 (see Abstr.
1 of 1960) p. 264-6. In French.
Discusses the effect of overdevelopment of D1 and K0 emulsions
elation to the separation of protons and alpha-particles by grain
nt. It is concluded that D1 is inherently more sensitive to
tons than the K0 emulsion. Overdevelopment results in grain
mping and appearance of fog in the latter material.
S.J.St-Lorant

539.1.07 : 539.17

12771 THE CALCULATION OF THE RANGE—ENERGY RELATIONSHIPS FOR SEVERAL IONS IN NUCLEAR
ULSIONS. P.Colle and P.Demers.
ırticle photography" Conference. Montreal 1958 (see Abstr. 2261
1960) p. 267-70. In French.
Some details are given of the method by which the range—energy
ationships given by Demers (Ionographie, 1958), were obtained,
particular a tabular summary of the relevant constants and inter-
ation intervals used over the range Z = 1 to Z = 37.
S.J.St-Lorant

539.1.07 : 539.17

12772 THE RANGE AND IONIZATION OF HEAVY IONS IN EMULSION. H.H.Heckman, F.M.Smith and W.H.Barkas.
article photography" Conference. Montreal, 1958 (see Abstr. 2261
1960) p. 271-2. In French.
Several types of emulsion were exposed to a heavy ion beam of
Hilac and the range—energy relationships were studied for
rogen, oxygen, neon and argon with energies up to 10 MeV per
leon. The techniques used included measurements on ion—
ton collisions in which both scattered particles came to rest in
same film, and measurements after magnetic analysis. The
ergy loss was estimated from the grain density along the track
low-sensitivity emulsions. S.J.St-Lorant

539.1.07

12773 BACKGROUND FOG AND THE APPARENT LENGTH OF TRACKS IN NUCLEAR EMULSIONS. T.A.Brody.
article photography" Conference. Montreal, 1958 (see Abstr.
61 of 1960) p. 273. In French.
The difference between the true length and the apparent length
a track in a nuclear emulsion is a function of the linear density
the grains in the track and of the background grain density. A
rrection term to take this into account is obtained and its applica-
n and useful range demonstrated for the Ilford C2 emulsion.
S.J.St-Lorant

539.1.07 : 77

12774 THE INFLUENCE OF THE pH AND THE DEVELOPMENT TEMPERATURE ON THE DISTORTION OF
JCLEAR PHOTOGRAPHIC EMULSIONS. J.P.Dentan.
article photography" Conference. Montreal, 1958 (see Abstr. 2261
1960) p. 274-5. In French.
Discusses briefly the extent to which variations in the pH of the
veloper and the relative temperatures in the two-stage develop-
ent produce distortion in 600 μ G5 emulsion films.
S.J.St-Lorant

539.1.07

12775 THE EFFECT OF DISTORTION IN MEASUREMENTS OF ANGULAR DISTRIBUTIONS IN NUCLEAR
IULSIONS. C.Castagnoli and A.Manfredini.
article photography" Conference. Montreal, 1958 (see Abstr.
61 of 1960) p. 276-80. In French.
A theoretical analysis based on the representation of distortion
two vectors of first and second order is made of an isotropic
stribution of tracks in a distorted medium. The results are
mpared with experimental measurements on π—μ decays at rest.
S.J.St-Lorant

539.1.07 : 539.12

12776 CONSTANT SAGITTA MEASUREMENTS ON PROTONS IN G5, K5 AND L4 EMULSIONS.
C.Amerighi, M.Di Corato and A.Fedrighini.
article photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 281-2. In French.

A comparison of the "noise" levels determined with different combinations of the same basic cell scheme using the three types of emulsion. An averaging procedure was employed in taking the readings. S.J.St-Lorant

539.1.07

12777 THE THIN-DOWN OF THE TRACKS OF HEAVY NUCLEI IN NUCLEAR EMULSIONS.
P.G.Bizzetti and M.Della Corte.
"Particle Photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 283-93. In French.

A systematic study was made of the thin-down of proton, helium, C^{12} and O^{16} tracks in Ilford G5 emulsion. The results are shown to be in complete disagreement with existing theories which seek to explain this process in terms of electron capture. A new model is therefore proposed, based on the mechanism of δ-ray formation at low electron energies. The width (λ) of the track is described at any point by a relationship of the type $\lambda = \lambda_0 + \lambda(\beta, Z)$, where λ_0 takes into account effects due to development and $\lambda(\beta, Z)$ is a function of the charge and velocity of the ion. The functional form of $\lambda(\beta, Z)$ is evaluated. S.J.St-Lorant

539.1.07 : 77

12778 A QUANTITATIVE STUDY OF THE RESOLUTION EFFECTS OF VARIOUS MEANS OF DEVELOPMENT ON THE HEAVY-ION TRACKS. C.Gegauff and J.P.Longchamp.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 294-9. In French.

The structure, i.e. the profile, of α-particle and heavy-ion tracks was analysed in the Ilford G5 and C2 emulsions to determine the extent to which the width is influenced by variations of the development time and the nature of the developer. S.J.St-Lorant

539.1.07

12779 PHOTOMETRIC MEASUREMENTS OF PARTICLE TRACKS IN DILUTED EMULSIONS.
G.Philbert, L.Van Rossum and M.Meschonnic.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 300-3. In French.

An attempt is made to determine the functional dependence of the "blackness" of track on the grain density for particles of unit charge, and to compare the blackening produced by a particle of given energy in emulsions of different halide content. The possibility of photometrically resolving charges of 1 and 2 units in different types of emulsion is discussed. S.J.St-Lorant

539.1.07 : 535.8

PRECISION IN MICROSCOPIC ANALYSIS OF PARTICLE TRACKS. See Abstr. 12477

539.1.07 : 77

12780 THE THEORY OF THE LATENT IMAGE PRODUCED BY CHARGED PARTICLES AND THE EFFECT OF FLUCTUATIONS OF THE SPECIFIC ENERGY LOSS ON THE GRAIN FORMATION IN THE REGION OF MINIMUM IONIZATION.
M.C.Le Gentil and M.Morand.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 304-7. In French.

Starting from the recent theory of the latent image considered by Mitchell (Abstr. 12926 of 1959), the possible processes leading to formation of positive holes in the halide lattice in sufficient numbers to render the crystal developable are investigated. S.J.St-Lorant

539.1.07 : 77

12781 A MODEL OF THE GRAIN STRUCTURE OF TRACKS TAKING INTO ACCOUNT CONTACT DEVELOPMENT.
I.Ahmad.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 308-13. In French.

An extension of the Herz model of granulation is proposed to include the effects of grain growth resulting from contact development of neighbouring grains unaffected by the incident particle.
S.J.St-Lorant

539.1.07

12782 THE NUCLEAR EMULSION CONSIDERED AS A GENERATOR OF PULSES.
I.Ahmad, P.Colle, P.Demers and J.Demers.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 314-16. In French.

A track in an emulsion, examined photometrically, is regarded,

by analogy with the more usual electronic detectors, as constituting a source of pulses, the analysis of which is capable of yielding detailed information concerning the nature and properties of the particle responsible for the track. One particular method, the Fourier analysis of the photometer response is briefly discussed.
S.J.St-Lorant

539.1.07

12783 AN OPTICAL MODEL OF THE GRAIN STRUCTURE OF TRACKS. P.Demers and I.Ahmad.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 317-21. In French.

To obtain a more realistic representation of a track, the absolutely black grains and the transparent gaps of current models are replaced by an "image trajectory", the optical density of which is a continuously varying function of the three coordinates giving the location of any point in the track. For simplicity two of the variables are taken as fixed and the density distribution is taken along the line of flight of the particle. This distribution resembles an ideal telegraphic signal response curve and it can be analysed as such. Preliminary results making use of the model are discussed.
S.J.St-Lorant

539.1.07

12784 EQUIPMENT AND METHODS FOR AUTOMATIC TRACK ANALYSIS. W.H.Barkas.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 325-42. In French.

A survey of automatic devices currently in use at the Radiation Laboratory, University of California. The equipment in all cases is not designed to supplant the observer but to facilitate and to speed up the collection of data from nuclear emulsions. Pellicle registration is discussed, and equipment used for automatic measurement of coordinates and ranges, grain density and multiple scattering is described. Extensive use is made of IBM cards for storage of information as well as for input to an IBM 650 computer, and of "Keysort" cards for general information collected during the scanning and for details of the analysis of individual events. S.J.St-Lorant

539.1.07

12785 A COMPARISON OF AUTOMATIC SCANNING SYSTEMS. W.M.Gibson.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 365-9. In French.

A general survey of the progressive mechanization of scanning and analysing methods currently in use in emulsion physics. The features of each system are briefly described with remarks on the performance expected from such an aid for it to be useful from a practical point of view. S.J.St-Lorant

539.1.07

12786 APPARATUS FOR AUTOMATIC MEASUREMENT OF THE MULTIPLE SCATTERING OF PARTICLES.
G.E.Belovitsky, L.N.Korabliev, L.V.Sukhov and I.V.Chtranikh.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 343-8. In French.

A system is described which, coupled to a modified microscope, performs all the operations necessary to obtain the multiple scattering parameters. The movement of a filar micrometer hairline is digitized photoelectrically, the calculation of the first and second differences being initiated by the cell size transducer mounted on the x-axis of the microscope. The accuracy of the apparatus is comparable to that achieved by an observer, the maximum disagreement being about 5%. S.J.St-Lorant

539.1.07

12787 A DEVICE FOR THE DETERMINATION OF THE MULTIPLE SCATTERING OF FAST CHARGED PARTICLES IN NUCLEAR PHOTOGRAPHIC EMULSIONS.
J.Rüfenacht, R.Weill, M.Gailloud and J.Lagorsse.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 349-50. In French.

The rotation of the drum of a filar micrometer is transmitted via two servo-mechanisms to a counter and a printing device. Synchronization of the two rotors is achieved by a motor coupled to a feed-back circuit of the receiver servo. The advantages of the system lie in the reliability and ready availability of the components.
S.J.St-Lorant

539.1.0

12788 SEMI-AUTOMATIC MEASUREMENT OF TRACK PROFILES IN NUCLEAR EMULSIONS.
B.Stiller and F.I.Louckes.
"Particle photography" Conference. Montreal, 1958 (See Abstr. 2261 of 1960) p. 351-3. In French.

Describes a system of two parallel and one perpendicular hairlines mounted on accurate ways and controlled with flexible drives, the unit being attached to one eyepiece of the microscope. The relative displacement of the parallel lines is digitized with a linear transducer and displayed graphically. The sensitivity of the device is adjustable; the maximum is about 0.01 μ per division. Reproducibility is of the same order as that attainable with the commercially available "Poohstrolino". S.J.St-Loran

539.1.07 : 535.

12789 AN IMAGE ROTATOR FOR MEASUREMENTS IN NUCLEAR EMULSIONS. A.Bonetti and C.Cantu.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 226 of 1960) p. 357-8. In French.

For the alignment of the track image in certain types of measu rement the use of a rotating stage may be inconvenient or too slow The rotation about the optical axis of the microscope is therefore achieved by means of a movable system of three plane mirrors mounted on the eyepiece tube. Mirrors are used in preference to a Wollaston prism in order to eliminate the distortion of the image produced by a beam of not quite parallel light. S.J.St-Lorant

539.1.07 : 535.

12790 USE OF A MICROSCOPE WITH A SCANNING BEAM IN THE ANALYSIS OF NUCLEAR EMULSIONS.
J.G.McEwen and J.Hébert.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 370-2. In French.

Describes the construction of an automatic apparatus designed to count the number of tracks crossing a field of view in a microscope. S. J.St-Lorar

539.1.07 : 535

A THERMALLY INSULATED MICROSCOPE FOR TRACK ANALYSIS. See Abstr. 12476

539.1.07 : 539.1

12791 THE USE OF DIAMOND GRAINS EMBEDDED IN PHOTOGRAPHIC EMULSIONS IN THE STUDY OF NUCLEAR REACTIONS ON CARBON. C.Xuan and R.Chastel.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 382-6. In French.

Diamond grains, in the form of dust with a mean grain diamete of 0.7 μ sandwiched between two nuclear emulsion films, were used as the detector of the $C^{12}(n,\alpha)Be^{9}$ reaction at an incident neutron energy of 14 MeV. The preparation of the diamond-loaded emulsion is described in considerable detail. S.J.St-Loran

539.1.07 : 539.1

12792 SOME RESULTS ON THE SPECTRA OF FAST NEUTRO OBTAINED BY MEANS OF NUCLEAR EMULSIONS.
S.Blaize.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 387-90. In French.

The neutron spectra in a number of channels of the ZOE reactor were determined by the recoil-proton technique. Two assumptions were made: (a) the neutrons measured are produced in the uranium bars nearest to the exit channel and (b) the neutrons flux can be split into two parts, one containing those neutrons which have been in collision with oxygen nuclei without a loss of energy and the other those which have been moderated by the deuterium shield. The experimental histograms are in very good agreement with the predicted spectra. S.J.St-Loran

539.1.07 : 539.1

12793 ANALYSIS OF NEUTRON SPECTRA (250 KeV TO 5 Me BY MEANS OF NUCLEAR EMULSIONS. C.Beets.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 391-8. In French.

The measurement of the ranges of the recoil protons from (n,p) collisions, usually in the region of 10μ, is critically depender on the optical conditions and on the criteria of observation. To obtain maximum reproducibility a photographic method, making us he Sabattier effect, was developed. The experimental procedure escribed and the usefulness of the method illustrated by a ıber of examples. S.J.St-Lorant

539.1.07 : 539.12

12794 MEASUREMENT OF THE FLUX OF THERMAL NEUTRONS IN A UNIFORM MEDIUM BY MEANS OF RON-LOADED NUCLEAR EMULSIONS.
Jeets, H.Breny and J.Fournaux.
ırticle photography" Conference. Motreal, 1958 (see Abstr. 2261 .960) p. 399-410. In French.

A discussion is given of recent improvements in the estimation ıeutron fluxes with recoil-proton techniques in nuclear emulsions. ticular attention is drawn to determination of the uniformity of distribution of boron throughout the volume of the emulsion. A method of counting the recoils and analysing the data is described. ıe theoretical aspects of these procedures are considered, and umber of illustrations given. S.J.St-Lorant

539.1.07

12795 NUCLEAR EMULSIONS UNDER HIGH PRESSURES OF HYDROGEN. A.Bonetti and L.Scarsi.
ırticle photography" Conference. Montreal, 1958 (see Abstr. 1 of 1960) p. 411-12. In French.

Describes the technique of manipulating nuclear emulsions red over thin tubes containing gases at very high pressures, in ticular hydrogen. S.J.St-Lorant

539.1.07 : 537.59

12796 THE EXPOSURE OF EMULSIONS IN FREE SPACE. H.Yagoda.
ırticle photography" Conference. Montreal, 1958 (see Abstr. 1 of 1960) p.417. In French.

A brief summary of results obtained in a series of five Aerobee ket flights with emulsion containers. The exposures usually had uration of 300 sec under conditions closely approximating those free space, with only about 137 mg/cm^2 of aluminium above the ulsions. S.J.St-Lorant

539.1.07 : 537.59

12797 SOME APPLICATIONS OF NUCLEAR EMULSIONS IN THE STUDY OF THE COSMIC RADIATION. HEAVY PRIMARY NUCLEI. II. HIGH-ENERGY JETS.
M.Shapiro.
article photography" Conference. Montreal, 1958 (see Abstr. 1 of 1960) p. 418-30. In French.

As an illustration of the use of nuclear emulsions in problems particle physics, the properties of the cosmic radiation are cussed in general terms, in particular the heavy nuclei and the aracteristics of high-energy jets. The article deals with the ıal classification of the primary radiation into the light, medium heavy components, the energy spectra of each group and the ficulties associated with an estimation of the relative abundance the light elements in the primary flux. Several aspects of the dy of nuclear interactions at ultra-high energies are mentioned, ch as the nature of the secondaries, the pion multiplicity, strange rticle production, the angular and energy distributions of the condary products, the inelasticity of the collisions and the perıtage conversion of the incident energy into electromagnetic scades. S.J.St-Lorant

539.1.07

12798 A FIRST ATTEMPT TO COMPARE THE CANADIAN AND ILFORD G5 PHOTOGRAPHIC EMULSIONS. A.Hée.
article photography" Conference. Montreal, 1958 (see Abstr. 1 of 1960) p. 442-3. In French.

It is concluded that although the Canadian emulsion consists of remely fine grains and is superior to the G5 emulsion in this spect, it has rather poor physical properties: it is difficult to ain a uniform film, the adhesion of the gel to the glass is low and intering of the film into small fragments during the drying stage common. S.J.St-Lorant

539.1.07

12799 REMARKS ON THE USE OF FINE-GRAIN EMULSIONS FOR TRACK AUTORADIOGRAPHY. G.Guidotti.
article photography" Conference. Montreal, 1958 (see Abstr. 1 of 1960) p. 450-4. In French.

A comparison of the autoradiographs in three emulsions, G5, K5 and L4, of histological specimens treated with C^{14} shows that the higher resolving powers of the K5 and L4 emulsions render them eminently suitable for this technique. S.J.St-Lorant

539.1.07

12800 MAGNETICALLY OPERATED MASS-MARKER. J.J.Brown, R.I.Reed and W.Simpson.
J. sci. Instrum., Vol. 37, No. 7, 236-8 (July, 1960).

The construction and operation of a magnetically operated mass-recorder which is suitable for use with the mass spectrometer, type M.S.2 is described. Certain precautions in its operation are discussed. On the present evidence it operated with such accuracy as to be useful in a mass-range of up to 500 mass-units.

539.1.07

12801 TRANSISTORIZED PRECISION RATEMETER. G.Giannelli and V.Mandl.
Rev. sci. Instrum., Vol. 31, No. 6, 623-5 (June, 1960).

A linear ratemeter based on a special circuit with a saturated-core blocking oscillator is described. This circuit feeds a capacitance with a calibrated quantity of electric charge for every input pulse. The instrument is characterized by an absolute zero stability, a good linearity, and independence from temperature.

539.1.07

12802 COMPUTER FOR THE IDENTIFICATION OF CHARGED PARTICLES. R.H.Stokes.
Rev. sci. Instrum., Vol. 31, No. 7, 768-72 (July, 1960).

An improved computer circuit is described which can be used with appropriate counters to identify charged particles. Previously this system has been used to identify protons, deuterons, and tritons. More recently the computer has been used to separate He^3 and He^4 events. A sample calculation of the performance is given which shows that He^3 and He^4 events can be distinguished over a wide energy range with a single choice of computer parameters. Consideration is also given to the use of the method for low energy particles. It is concluded that, with easily attainable counter resolution, protons can be identified at energies extending below 1 MeV.

539.1.07 : 621.374.32

12803 HIGH SPEED SCALERS USING TUNNEL DIODES. P.Spiegel.
Rev. sci. Instrum., Vol. 31, No. 7, 754-5 (July, 1960).

A solid-state scaler circuit has been developed with a double pulse resolution of less than 50 nsec. It utilizes the characteristic of series-connected tunnel diodes wherein voltage is a multi-valued function of current. The decade scaler described requires very little power, may be microminiaturized, and is potentially more economical and easier to fabricate than contemporary scalers.

539.1.07

12804 AN EASY WAY OF CALCULATING THE COMPOSITION OF A TWO-COMPONENT SYSTEM FROM TWO-CHANNEL SPECTROMETRY. A.Bill, K.J.Öbrink and H.R.Ulfendahl.
Internat. J. appl. Radiation and Isotopes, Vol. 7, No. 2, 152-4 (Dec., 1959).

The method, which is applicable to any two overlapping spectra, enables relative concentrations to be determined from the intensity in two channels, provided that relative intensities in the two channels are also determined for each component spectrum separately. A simple way of analysing results is given, and an electrical analogue to aid calculation is described. A.E.I. Research Laboratory

539.1.07

12805 MEASUREMENT OF THE MOMENTA OF FAST CHARGED PARTICLES AND INVESTIGATION OF NUCLEAR INTERACTIONS IN THE 10^{10}-10^{12} eV ENERGY RANGE.
M.I.Daion and V.Kh.Volynskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 906-9 (Oct., 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 648-50 (April, 1960).

A new method for direct measurement of the momenta of charged particles in a magnetic field in the 10^{10}-10^{12} eV energy range is proposed which is based on simultaneous use of spark counters and nuclear emulsions. The possibility of application of the method to measurement of the momenta spectra and investigation of nuclear interactions between protons and matter is considered.

539.1.07 : 77

12806 PHOTOGRAPHIC AND ELECTRONIC METHODS OF MEASUREMENT IN HIGH-PRECISION MASS SPECTROGRAPHS. H.Ewald.

"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 375-81. In French.

The application of photographic techniques to mass-spectrographic measurements is discussed. It is pointed out that the present focusing systems are definitely unsuitable for work of high accuracy with photographic plates. The construction of a double-focusing instrument is described where photographic separation of adjacent isotopes can be made as good as that achieved with electronic methods, with several added advantages. S.J.St-Lorant

NUCLEAR FIELD THEORY

539.11

12807 DECOMPOSITION OF DIRECT PRODUCTS OF REPRESENTATIONS OF THE INHOMOGENEOUS LORENTZ GROUP. J.S.Lomont.

J. math. Phys. (New York), Vol. 1, No. 3, 237-43 (May-June, 1960).

The direct products of the physically significant, irreducible, unitary representations of the proper, orthochronous inhomogeneous Lorentz group are reduced. It is shown that $\Gamma m_1 s_1 \otimes \Gamma m_2 s_2$ contains only irreducible components of the form Γ_{mJ}, and that Γ_{mJ} occurs with nonzero multiplicity only if $J-(s_1+s_2)$ is an integer. For such J's the multiplicity of $\Gamma_{m,J}$ for $J \geq s_1 + s_2$ is $(2s_1+1)(2s_2+1)$ for each positive m. $\Gamma m_1 s_1 \otimes \Gamma s_2^{(\pm)}$ contains only irreducible components of the form Γ_{mJ}, where $J-(s_1+s_2)$ in an integer. The multiplicity of such $\Gamma_{m,J}$ for $J \geq s_1 + s_2$ is $(2s_1+1)$ for each positive m.

$\Gamma s_1^{(\epsilon 1)}{}_{\mathrm{O}}\Gamma s_2^{(\epsilon 2)}$ contains irreducible components of the form $\Gamma s^{(\epsilon)}$ and $\Gamma_{m,J}$ where $s = |\epsilon_1 s_2 + \epsilon_2 s_1|$, $\epsilon = \text{sign}\,(\epsilon_1 s_1 + \epsilon_2 s_2)$ and $J-(s_1+s_2)$ is an integer. The multiplicity of $\Gamma_{m,J}$ is one for $J \geq (s_1+s_2)$ and for each positive m. The multiplicity of $\Gamma_s^{(\epsilon)}$ is infinite. The symmetrized squares are also analysed. Numerous examples are given.

539.11 : 535.1

PARTICLE WAVE PROPAGATION IN LORENTZ SYSTEMS.
See Abstr. 12465

539.11

12808 A CLASS OF SIMPLE FIELD THEORIES AND VON NEUMANN'S INFINITE DIRECT PRODUCT SPACES. M.Schwartz.

Nuovo Cimento, Vol. 15, No. 3, 334-50 (Feb. 1, 1960).

The fixed scalar boson field is reanalysed in an attempt to clarify certain issues raised by Van Hove and Miyatake regarding the orthogonality of certain Hilbert spaces. The discussion is generalized to include a more general class of models of which the scalar boson field is a special case.

539.11

12809 q-NUMBER COMMUTATION RELATIONS AND THE PHYSICAL CONTENT OF A SIMPLE FIELD THEORY. G.Heber.

Acta phys. Polon., Vol. 18, No. 6, 581-7 (1959). In German.

It is shown that there exist q-number commutation relations with the following properties: (1) They are relativistically invariant and microscopically causal. (2) The physical content of the isolated field is as usual; in particular there are particles as eigenstates of the field. (3) The field interacts with other fields in an unconventional way. These facts are proved for a real scalar field with zero rest mass.

539.11

12810 INVARIANCE AND CONSERVATION IN FIELD THEORY. APPLICATION OF THE GENERAL THEORY TO THE STUDY OF A SPINOR FIELD. J.Winogradzki.

Cahiers de Phys., Vol. 13, 17-26 (Jan., 1959). In French.

A theorem of E.Noether is discussed, showing that for a classical field derived from a variational principle whose action integral is invariant with respect to a Lie group G_r, there are r conservation equations. Application of the explicit form of the theorem immediately yields the 4 + 6 energy—momentum and angular momentum conservation laws common to all relativistically invariant fields. The conserved current for charged fields, corresponding to gauge invariance, is derived and the general conservatio equations are particularized to the case of the Dirac spinor field. R.F.Peierls

539.1

12811 DOUBLE COMMUTATOR IN QUANTUM FIELD THEOR R.F.Streater.

J. math. Phys. (New York), Vol. 1, No. 3, 231-3 (May-June, 1960).

A representation is obtained for the most general function with the properties of the double commutator, including nonzero mass thresholds but not the Jacobi identities. The thresholds are proved to satisfy triangular inequalities (without using any more informati which are always true physically. The problem of incorporating a discrete level at the mass of a stable particle is not solved.

539.1

12812 ON THE CUT-OFF THEORY IN QUANTUM FIELD THEORY. S.Aramaki.

Progr. theor. Phys., Vol. 18, No. 3, 320-2 (Sept., 1957).

A discussion is given of whether the Gell-Mann—Low cut-off method reduces to the original divergent theory when the cut-off momentum tends to infinity. It is shown that this is not true in the Lee model, or in quantum electrodynamics in second and fourth orders of perturbation theory. E.J.Squire

539.1

12813 ON THE REPRESENTATIONS OF FIELD QUANTITIES. H.Wakita.

Progr. theor. Phys., Vol. 20, No. 1, 35-52 (July, 1958).

A study is made of the kind of mathematical framework which would be adequate for the future quantum theory of fields, and whic would be physically correct and mathematically rigorous. From th physical point of view, it is assumed that the field quantities form a * -algebra and that the states are linear functionals of it. Field quantities must have many physical properties, and so the * -algebr must have corresponding properties, which are described in a math matically precise manner. From these properties it is shown tha this * -algebra can be represented by an operator algebra in a separable Hilbert space, and that states are closely related to vectors of this space.

539.1

12814 ON A NON-ADIABATIC APPROXIMATE METHOD IN THE NON-LINEAR INTERACTION THEORY. S.Ozaki.

Progr. theor. Phys., Vol. 20, No. 2, 239-41 (Aug., 1958).

The anharmonic oscillator problem is considered, using Feynman's functional integral method. Approximate eigenfunctions are found to be singular at zero coupling constant. D.W.L.Sprun

539.1

12815 A DYNAMICAL PRINCIPLE FOR SECOND-ORDER EQUATIONS. A.A.Borgardt.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1928-9 (June, 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1371-2 (Dec., 1959).

The application of Schwinger's dynamical principle gives uniqu commutation relations for fermion fields and for boson fields. W.A.Hepne

539.11

12816 THE METHOD OF QUASI-REAL PROCESSES IN QUANTUM ELECTRODYNAMICS. P.Kessler.

Cahiers de Phys., Vol. 14, 41-54 (Feb., 1960). In French

Using a field-theory generalization of the semi-classical William and Weizsäcker method, a new method for the calculation of relativisti processes in quantum electrodynamics is developed. The method consists in defining probabilities for partial virtual processes (quasi-r processes), such as the scattering of a relativistic particle with emission of a real or virtual photon, or relativistic pair creation by a photon. Examples are given and further generalization is discussed. P.M.Davidson

539.11

12817 A REMARK ON BOPP-PODOLSKY ELECTRODYNAMI J.Kvasnica.

Czech. J. Phys., Vol. 10, No. 2, 81-90 (1960). In Russian.

A description of the electromagnetic field in vacuum as a specific bi-field, formed by the vectors E,B and H,D, leads, on the assumption of a non-local relation between the components of the

ield, to electrodynamics of the type $L(\Box)\Box A_\mu = -j_\mu$, where $L(\Box)$
rational function of $\Box$. The scattering of electrons in a Bopp—
olsky field of force is studied and compared with the results of
stadter's experiments (Abstr. 2524 of 1957). The close connec-
is shown between electrodynamics with higher derivatives and
results and methods of modern quantum electrodynamics (pola-
tion of electron—positron vacuum, Pauli—Villars regularization).

539.11

2818 APPLICATION OF DISPERSION RELATIONS FOR TESTING QUANTUM ELECTRODYNAMICS AT SMALL
TANCES. P.S.Isaev and I.S.Zlatev.
lear Phys., Vol. 16, No. 4, 608-18 (June (1), 1960).

Corrections to the Bethe—Heitler bremsstrahlung formula in
lowest approximation in e are calculated using the method of
persion relations. The problem of the limit of applicability of
ntum electrodynamics at small distances is considered.

539.11

2819 USE OF DISPERSION RELATIONS FOR A TEST OF QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES.
Zlatev and P.S.Isaev.
eksper. teor. Fiz., Vol. 37, No. 4(10), 1161-2 (Oct., 1959). In
sian. English translation in Soviet Physics—JETP (New York),
. 37(10), No. 4, 826-7 (April, 1960).

Previous calculations have employed an inadequate approxi-
ion. The more accurate calculations here given show a satis-
ory agreement with experiment. P.M.Davidson

539.11

12820 FORMAL PARADOX IN QUANTUM ELECTRODYNAMICS. H.M.Fried.
ys. Rev., Vol. 118, No. 6, 1642-5 (June 15, 1960).

The formal paradox concering the vanishing of the photon self-
ss, obtained by a formal manipulation, is examined in Källén's
mulation of electrodynamics (Abstr. 7961 of 1952). It is suggested
t this difficulty can be removed, and the formal manipulation
ained, by a regularization of the Heisenberg operators. An
ernate method of obtaining the spectral function of the photon
nmutator is described, and a possible consequence of regulari-
ion, in connection with the proof of the renormalization constants'
ergence, is briefly discussed.

539.11

12821 QUANTUM ELECTRODYNAMICS WITH THE INDEFINITE METRIC: NON-LORENTZ-INVARIANCE
THE GUPTA FORMALISM. S.Sunakawa.
ogr. theor. Phys., Vol. 19, No. 3, 221-37 (March, 1958).

Gupta's quantum electrodynamics (Abstr. 6997 of 1950) is
estigated in several kinds of representations, and it is shown that
Gupta metric operator for the free field can be used even in the
se of the interacting fields. It is also shown that the Gupta's theory
not invariant under the Lorentz transformation.

539.11

12822 SOME GENERAL PROPERTIES OF THE PHOTON PROPAGATION FUNCTION IN QUANTUM ELECTRO-
NAMICS. A.A.Ansel'm.
. eksper. teor. Fiz., Vol. 38, No. 4, 1288-96 (April, 1960).
Russian.

By comparing the spectral expansion of the photon Green's
ction with the renormalizability property, the behaviour of the D-
ction was investigated for very large energies and $e^2 = 1/137$, as
ll as for very large charges but not very high energies. With an
curacy to within a numerical parameter, the dependence of the
function on charge was established in the first case and on the
ergy in the second.

539.11

12823 ON NONLOCAL EFFECTS IN WEAK INTERACTIONS. M.Hessler.
k. Fys., Vol. 16, Paper 44, 533-40 (1960).

Weak interactions are assumed to be slightly nonlocal, due to
occurrence of a heavy intermediate particle. When the term for
s particle is eliminated from the Lagrangian, an expression arises
which the lepton and nucleon currents interaction at different
ints are coupled by a Yukawa potential. The nonlocal effects in
inverse β process, $p + e^- \rightarrow n + \nu$, and in μ decay are calculated
ing V—A coupling. It is found that the value of the Michel para-
eter tends to increase about 0.75. The coupling constant, g^2, used in the nonlocal interaction Hamiltonian has the dimension of charge squared in contrast to the constant of the local theory, which has the dimension of charge squared times length squared and is the one experimentally determined. By studying the relation between these two constants it is found that the experimental ρ value which limits the characteristic length for the nonlocal effect to $\cong 10^{-13}$ cm gives a corresponding limitation to g^2 of $g^2 \geq 10^{-24}$ cgs units.

539.11

12824 NORMALIZATION AND INTERPRETATION OF FEYNMAN AMPLITUDES. H.S.Green.
Nuovo Cimento, Vol. 15, No. 3, 416-33 (Feb. 1, 1960).

A general method is given for normalizing Feynman amplitudes and using them to calculate expectation values. The method is easily applicable to bound states and composite states. Two applications are considered in detail. The first example is the normalization of Bethe—Salpeter amplitudes, where it is found that previously suggested normalization conditions are inadequate. The second example is the renormalization of the electron amplitude for first-order self-energy processes, and here a method is suggested for making the self-energy finite. The self-energy is three times the energy of the bare electron, in this approximation.

539.11

12825 BOSON FURRY THEOREM.
D.C.Peaslee and M.T.Vaughn.
Phys. Rev., Vol. 119, No. 1, 460-2 (July 1, 1960).

A Furry theorem (Abstr. 651 of 1937) for heavy mesons and photons is given for a class of highly symmetric interactions, neglecting the Ξ -N mass difference. Because of this neglect most rules are only approximately valid, but a few depend on charge conjugation alone and are absolute.

539.11

12826 HIGH-ENERGY LIMIT OF FORM FACTORS.
S.D.Drell and F.Zachariasen.
Phys. Rev., Vol. 119, No. 1, 463-6 (July 1, 1960).

This theorem is proved: for finite charge renormalization constant Z_3^{-1}, the form factors describing any vertex with two particles on the mass shell must vanish at infinite momentum transfer. The relation of this result to the work of Lehmann, Symanzik, and Zimmermann (Abstr. 9411 of 1955) is discussed.

539.11

12827 THE UTILITY OF THE "INDIVIDUAL Γ_5 TRANSFORMATION". K.Fujii and K.Iwata.
Progr. theor. Phys., Vol. 18, No. 6, 666-8 (Dec., 1957).

Discusses a model in which all elementary particle interactions are of Fermi type, and parity is not conserved in weak interactions. (See also following three abstracts, in which modifications and developments of this paper are given). R.J.N.Phillips

539.11

12828 THE PHENOMENOLOGICAL MODEL OF THE INTERACTION OF ELEMENTARY PARTICLES.
K.Fujii and K.Iwata.
Progr. theor. Phys., Vol. 19, No. 5, 475-84 (May, 1958).

The correlations between the invariant character under the space inversion and the strength of the interactions are displayed by the simple principles, i.e., the composite property of strange particles and the individual Γ_5 transformation invariance. The applications of these principles to lepton processes are satisfactory.

539.11

12829 THE SPIRALITY OF THE DECAY PRODUCT.
K.Fujii and K.Iwata.
Progr. theor. Phys., Vol. 19, No. 5, 589-91 (May, 1958).

Preliminary account of following abstract.

539.11

12830 PHENOMENOLOGICAL MODEL ON THE INTERACTIONS OF ELEMENTARY PARTICLES. II.
K.Fujii and K.Iwata.
Progr. theor. Phys., Vol. 20, No. 2, 126-32 (Aug., 1958).

Many authors have shown that the universal V—A coupling of the Fermi interaction is not inconsistent with various experimental results. Their assumptions are more or less ad hoc. Here it is shown phenomenologically that the universal V—A coupling is a natural and almost unique consequence of the authors' previous standpoint; especially, a possibility of S-T-P coupling of β-decay interaction is definitely excluded. One additional assumption is made concerning the relation between a weak boson—fermion interaction and the fundamental interaction.

539.11

12831 THE CONSERVATION LAWS IN THE LEPTON PROCESS AND TWO KINDS OF NEUTRINOS. I.Kawakami.

Progr. theor. Phys., Vol. 19, No. 5, 459-69 (May, 1958).

An attempt is made to forbid the unwanted processes involving leptons by assuming the conservation law of lepton number and that of neutrino charge. To do this, suitable assignment of these quantum numbers of each lepton is necessary in addition to the assumption of the existence of two kinds of neutrinos (a right circularly polarized neutrino and a left polarized neutrino). The neutrinoless lepton processes are successfully forbidden, except for the lepton pair processes, and the theoretical predictions for π-μ-e-decay and β-decay agree well with experiment. In π-μ-e-decay and β-decay, the vector and axial vector couplings are preferable if the interaction Hamiltonians are written in the form of charge exchange theory. The other sort of unwanted processes than neutrinoless ones, $\pi \to e + \nu$ and $\pi \to e + \nu + \gamma$, are relatively (or dynamically) forbidden from the view-point of the universal Fermi interaction.

539.11

12832 A COVARIANT INTERPRETATION OF THE EXISTENCE OF THE PARITY NON-CONSERVATION AND THE NEW FREEDOMS FOR ELEMENTARY PARTICLES. K.Goto.

Progr. theor. Phys., Vol. 19, No. 5, 592-4 (May, 1958).

By assuming a non-Riemann deviation from the Minkowskian structure of space-time, of the order of magnitude of the weak interaction coefficient, the possible existence of a covariant interaction term, occurring only in weak interactions, is demonstrated, and it is shown that two sorts of spin-like new freedoms can be derived from the structure of the four-dimensional space-time.

E.A.Sanderson

539.11

12833 HYPOTHESIS OF INVARIANCE OF CP ALONE AND CONSERVATION OF PARITY IN STRONG INTERACTIONS. C.Iso.

Progr. theor. Phys., Vol. 20, No. 4, 410-14 (Oct., 1958).

Conditions for parity conservation in strong interactions are derived under the assumption of CP invariance only. The required conditions are the following: either (a) the Fermi type interaction Hamiltonian should be charge-independent and its coupling type should be an arbitrary linear combination of s, t and p, or (b) the coupling type of the interaction Hamiltonian should be an arbitrary combination of s—p and t.

539.11 : 539.12

CASCADE REACTIONS AND PARITY CONSERVATION.

See Abstr. 11128

539.11

12834 ANALOGY BETWEEN WEAK AND ELECTROMAGNETIC INTERACTIONS. É.M.Lipmanov.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1233-6 (April, 1960). In Russian.

Weak and electromagnetic interactions are treated in such a manner that the electric current and charge currents in weak interactions can be derived from a single symmetric expression which includes the operators $\frac{1}{2} + \tau$ and $1 + \gamma_5$ after imposing the requirements of conservation of electric, lepton and baryon charges and vanishing of the photon mass. A certain "chirality" is ascribed to half-integral spin particles which is conserved in weak interactions. "Bare" Fermi particle doublets in weak and electromagnetic interactions are classified with respect to their electric charge, lepton or baryon charge and chirality values.

539.11

12835 A COMPOSITE THEORY OF ELEMENTARY PARTICLES. Y.Yamaguchi.

Suppl. Progr. theor. Phys., No. 11, 1-36 (1959).

The theory is based on six fundamental particles: p, n, Λ; ν, e and μ. Three types of interaction are assumed: very strong (VSI), moderately strong (MSI) and weak interactions (WI), besides electromagnetic couplings. The VSI is global (i.e. completely symmetrical with respect to p, n and Λ), and gives rise to major parts of baryonic mass but is missing among the leptons. This is why leptons are so light. This VSI is also responsible for the creation of various bound states, pions, kaons, etc., from baryon—antibaryon pairs. If there were only VSI, the masses of n, p, Λ and those of the pion and kaon would be equal. The charge-independent MSI splits the mass degeneracies between nucleons and Λ, pions and kaons, etc., and also (eν) and muon. It is concluded that the kaon is pseudoscalar and the Λ—Σ and Ξ—N relative parity must be odd, where the Σ or Ξ is the bound state of $\Lambda + \bar{N} + N$ or $\Lambda + \bar{N} + \Lambda$. There are open possibilities of existence of baryons and mesons with higher values of strangeness. The Feynmann—Gell-Mann theory of weak interactions can be consistently transferred into this scheme. Finally, the possible existence of extremely weak interactions (super weak interactions, SWI) is speculated (metastability of matter and charge non-conservation). See also following abstract.

539.11

12836 A MODEL OF STRONG INTERACTIONS. Y.Yamaguchi.

Suppl. Progr. theor. Phys., No. 11, 37-51 (1959).

Strong interactions are divided into two classes: very strong global interactions, and moderately strong charge-independent interactions. The aim is to transfer the content of the author's composite theory (see preceding abstract) into the framework of the Yukawa theory. Several interesting relations are found between the coupling constants for meson—baryon interactions (valid in the global approximation). The classifications (in the global approximation) and the "G" transformations of the mesons and the baryons are introduced.

539.11

12837 RENORMALIZATION IN THE PARITY NONCONSERVATION THEORY. B.L.Ioffe.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1263-75 (April, 1960). In Russian.

A method is proposed for renormalization of mass, charge and wave-functions in the parity nonconservation theory. The method is checked for the case when the "three Γ-approximation" equation is employed for the vertex part.

539.11 : 523.87

12838 THE UNIVERSAL FERMI INTERACTION AND ASTROPHYSICS. B.Pontekorvo [Pontecorvo].

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1615-16 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New Yor Vol. 36(9), No. 5, 1148-9 (Nov., 1959).

It is pointed out that, with the first-order weak neutrino—electron interaction, it becomes possible for the emission of a photo in electromagnetic processes to be replaced by emission of a $\nu\bar{\nu}$ pair. Although the probability for this is extremely small, the incomparably greater penetrating power of neutrinos makes it possibl for the bremsstrahlung energies emitted from a star into space in the forms of photons and neutrinos to become comparable at a certain stage of stellar evolution.

W.A.Hepne

539.11 : 539.12

12839 $|\Delta I| = \frac{1}{2}$ RULE AND THE WEAK FOUR-FERMION INTERACTION. S.Oneda, J.C.Pati and B.Sakita.

Phys. Rev., Vol 119, No. 1, 482-4 (July 1, 1960)

Although the usually considered diagram for the $\Lambda \to N + \pi$ decay arising from the interaction ($\bar{p}\Lambda$) ($\bar{n}p$) can explain the decay rate, branching ratio, and asymmetry parameter of Λ decay, it fails to explain (a) the approximate validity of the $|\Delta I| = \frac{1}{2}$ rule, and (b) tha the leptonic decay rates of the strange particles are slower than the universal rate, while the nonleptonic modes have nearly the univers rate. Introducing the effect of renormalization at the vertices of the strongly interacting particles phenomenologically, the authors have estimated the contributions to Λ decay from a set of diagrams satisfying the strict $|\Delta I| = \frac{1}{2}$ rule for both local and nonlocal Fermi interactions. It is found that they are considerably more important than the usual diagram. This makes it easier to explain the approximate $|\Delta I| = \frac{1}{2}$ rule. Moreover, since these diagrams do not contribute to leptonic modes, one can understand (b) by associating the strangene nonconserving current with a weaker coupling constant. These important classes of diagrams lead to different restrictions on the chiralities of the currents involved in Λ decay for local and nonlocal interactions.

539.1

12840 ANALOGY BETWEEN LORENTZ AND FOLDY—WOUTHUYSEN TRANSFORMATION. J.J.Giambiagi.

Nuovo Cimento, Vol. 16, No. 1, 202 (April 1, 1960).

539.11

2841 CONSTRUCTION OF WAVE EQUATIONS BY ERIKSSON'S SPINOR FORMALISM. B.Enflo.

. Fys., Vol. 16, Paper 40, 469-77 (1960).

A Lagrangian for a spin-$\frac{1}{2}$-particle in an electro-magnetic field
onstructed by means of Eriksson's spinor formalism in the most
eral way that is possible. Although the Lagrangian is not
riant for time reversal the formalism leads to equations of the
e type as the Dirac equation, except for a special choice of the
ameters, where equations are obtained, which seem to have no
sical significance.

539.11

2842 THE NON-RELATIVISTIC WAVE-FUNCTIONS ASSOCIATED WITH AN EXTENDED PARTICLE.

illion and J.P.Vigier.
. Acad. Sci. (Paris), Vol. 250, No. 19, 3131-3 (May 9, 1960).
'rench.

The non-relativistic wave mechanics of an extended particle is
racterized by invariance under the direct product of the Galilean
up and the three dimensional rotation group. The wave-functions
n extended particle are deduced from the irreducible representa-
is of these groups. J.Goldstone

539.11

12843 INVESTIGATION OF THE INVARIANCE GROUP IN THE THREE FUNDAMENTAL FIELDS MODEL. J.E.Wess.

vo Cimento, Vol. 15, No. 1, 52-72 (Jan. 1, 1960).

For a theory in which elementary particles are represented by
ducts of fundamental fields, consequences of an invariance group
investigated. The invariance group is the three-by-three unitary
up. Tensor-calculus is used to investigate the representations,
ntum numbers are defined and it is tried to identify certain
ilies of elementary particles with irreducible representations.

539.11

12844 COUPLED INTEGRAL EQUATIONS FOR THE NUCLEON AND PION ELECTROMAGNETIC FORM FACTORS.

Baker and F.Zachariasen.
s. Rev., Vol. 119, No. 1, 438-48 (July 1, 1960).

The dispersion relations for the nucleon isotopic vector form
tors and the pion form factor which take into account contributions
m both the 2π and NN intermediate states become a set of coupled
egral equations for the form factors if the four amplitudes $(\pi\pi|NN)$
$|\pi\pi)$ $(NN|\pi\pi)$ $(NN|NN)$ are assumed known. If these four amplitudes
replaced by their Born approximation values and spin and certain
ematic factors are neglected, the resulting set of coupled singular
egral equations can be solved exactly. Comparison of these exact
utions with the form factors obtained from the usual approxima-
n of retaining only the lowest mass state (i.e., the 2π state) con-
ns the hope that high-mass states do not contribute much to dis-
rsion integrals. It is also of interest that these solutions are
ained from dispersion relations without subtractions and satisfy
necessary conditions that they vanish at infinite momentum
nsfer and take on the value e at the origin for all values of the
pling parameters appearing in the equations.

539.11

12845 MASS LEVELS AND RELATIVE PARITIES OF BARYONS. H.Katsumori.

ogr. theor. Phys., Vol. 19, No. 3, 342-4 (March, 1958).

Calculation of the mass splittings of baryons are made in
vest order, with universal K—baryon and π—baryon coupling
nstants. The mass splitting of the N and Ξ particles requires
ir relative parity to be odd. Results are given for odd and even
ative parities of Λ and Σ. E.J.Squires

539.11

12846 A THEORY OF CLOTHED UNSTABLE PARTICLES. N.Nakanishi.

ogr. theor. Phys., Vol. 19, No. 6, 607-21 (June, 1958).

The clothed states of unstable particles are investigated on the
sis of quantum field theory, and thereby a new mathematical
tion, "complex distribution", is introduced. The exact eigenstate
total Hamiltonian with the complex eigenvalue, whole real part
presents the mass of the unstable particle and whose imaginary
t is interpreted as the half reciprocal of its lifetime, can then be
nstructed by means of the complex distribution. This state is not
servable, however. The physical state of the unstable particle is
erefore defined as an approximate state of the exact eigenstate,
ich exhibits physically reasonable behaviour.

539.11

12847 SOME CONSIDERATIONS ON A NONLINEAR FIELD THEORY. H.Kita.

Suppl. Progr. theor. Phys., No.9, 5-18 (1959).

The question is investigated whether the only one spinor field is sufficient to describe all the elementary particles and their interactions (including the gravitational interactions) by the spinor unified field theory. First it turns out that it is impossible to compose the fundamental metric tensor $g_{\mu\nu}$ out of ψ. This necessitates a return to the standpoint of the dualism of gravitational field and matter fields. Secondly, it is suggested that the spin affine connection Γ_μ in the general Dirac equation has a possibility of involving rather uniquely the fundamental strong and weak interaction terms as well as the electromagnetic interaction term. Thirdly, it is presumed, however, that at least three kinds of spinor fields, $\overset{(s)}{\psi}$, $\overset{(w)}{\psi}$ (both four components) and χ (two components) will be necessary in order to describe various kinds of elementary particles, based on a consideration about the weak interaction term, and on the empirical fact that there exist those elementary particles which have no strong interaction, as well as on the condition that the field equations should be derived from a variation principle. Thus a set of field equations is proposed.

539.11

12848 ON THE QUESTION OF ANOMALOUS EQUATIONS FOR SPIN-$\frac{1}{2}$ PARTICLES. I.Marek and I.Ulegla.

Zh. eksper. teor. Fiz., Vol. 37, No. 5, 1482-4 (Nov., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 5, 1051-2 (May, 1960).

This paper criticizes another by Shelepin on the same subject (Abstr. 1072 of 1959) on the ground that the assumption made therein, that the requisite algebra may be obtained in terms of direct products of Dirac matrices, is an unjustifiable one. P.K.Kabir

539.11

12849 MANDELSTAM REPRESENTATION FOR POTENTIAL SCATTERING. R.Blankenbecler, M.L.Goldberger, N.N.Khuri and S.B.Treiman.

Ann. Phys. (New York), Vol. 10, No. 1, 62-93 (May, 1960).

A proof of the Mandelstam representation for the scattering amplitude in the case of nonrelativistic potential scattering is given for a certain class of potentials. Fredholm theory and the Lehmann representation are employed in the proof. The unitarity condition is used to provide an iteration procedure for the exact determination of the weight function appearing in the Mandelstam representation, independent of the number of subtractions required in the latter. The analytic properties of the partial-wave amplitudes can be easily read off from the Mandelstam representation. It is shown that in cases where the partial-wave amplitudes can be represented by dispersion integrals without subtractions, they are uniquely determined, together with the energies of any bound states, in terms of the first Born approximation and the Mandelstam weight function, which is in principle known. In these circumstances, in effect, the Mandelstam representation and unitarity, together with the first Born approximation, completely define the nonrelativistic scattering problem in a way which replaces the Schrödinger equation. Some approximation methods are discussed and compared with exact solutions for s-wave amplitudes.

539.11

12850 DIFFRACTION THEORY FOR VERY-HIGH-ENERGY SCATTERING. K.R.Greider and A.E.Glassgold.

Ann. Phys. (New York), Vol. 10, No. 1, 100-26 (May, 1960).

In the simple diffraction theory, or black-sphere model, of Bethe and Placzek (1940), it is assumed that partial waves with $l \leq L$ are completely absorbed and partial waves with $l > L$ do not interact at all. (The projectile and target are assumed to have no spin or charge, so that l represents orbital angular momentum; L is a critical value of l usually related to the radius of the black sphere). This primitive but useful model is improved by taking into account (a) the gradual, rather than sharp, transition from maximum to zero absorption, (b) the generally small but important deviation from complete absorption, and (c) finite values for the real part of the scattering amplitude. By adoption of appropriate forms for these improvements, closed-form expressions for the various cross-sections are obtained. Whenever necessary, systematic approximation methods are developed which allow estimates of errors to be made. The results are shown to be model-independent, i.e. independent of the detailed way in which the above generalizations are made. Further simple improvements for the Coulomb field and spin-$\frac{1}{2}$ projectiles are also discussed. Finally, these methods are applied to the scattering of neutrons from nuclei for neutron energies in the range from 0.3 to 5.0 BeV.

539.11

12851 POLARIZATION TENSORS IN THE BORN APPROXIMATION. L.D.Puzikov and Ya.A.Smorodinskii.

Zh. eksper. teor. Fiz., Vol. 36, No. 3, 1585-6 (May , 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1126 (Nov., 1959).

Using the unitarity relations and time reversibility, the selection rule for the polarized states in the reaction a + a' → b + b' is obtained. W.A.Hepner

539.11

12852 ON THE METHODS OF BORN AND PAIS FOR FINDING PHASE SHIFTS. T.Titts. [Tietz].

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 294-5 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 207-8 (Jan., 1960).

A simple derivation of the method of Pais (Abstr. 840 of 1946) for obtaining approximate phase shifts is given. The method is shown to be better than the first Born approximation for scattering by a Gaussian nucleon—nucleon potential at 100 MeV.

E.J.Squires

539.11

12853 ON THE ANGULAR DISTRIBUTION OF THE SCATTERED PARTICLES IN COULOMB EXCITATION. J.Bang.

K. Danske Vidensk. Selsk. mat.-fys. Medd, Vol. 32, No. 5, 16 pp. (1960).

The angular distribution of scattered particles in Coulomb excitation is calculated for the case of electric quadrupole excitation and vanishing energy transfer; numerical values are given for a number of scattering angles and incident energies. Furthermore, an expression for the cross-section at a deflection angle equal to zero is derived, valid also for finite energy transfer.

539.11

12854 A GENERAL FORMULA FOR THE ELECTROMAGNETIC SCATTERING OF TWO DIFFERENT PARTICLES OF SPIN $\frac{1}{2}$. A.I.Nikishov.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1604-5 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1140-1 (Nov., 1959).

The formula for the scattering of high-energy electrons by nucleons is generalized to take into account the mass of the incident particle and its structure, which is described by two form-factors.

W.A.Hepner

539.11

12855 ON THE RELATIVISTIC RELATION BETWEEN POLARIZATION AND ASYMMETRY.

S.M.Bilen'kii and R.M.Rÿndin.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1609-10 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1144 (Nov., 1959).

It is shown that in the usual double-scattering experiment the asymmetry is equal to the square of the relativistically invariant polarization. W.A.Hepner

539.11

12856 SCATTERING BY A SINGULAR POTENTIAL IN PERTURBATION THEORY AND IN THE MOMENTUM REPRESENTATION. Ya.B.Zel'dovich.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 819-24 (March, 1960). In Russian.

A method is developed for treatment of scattering by a singular potential in the momentum representation and in perturbation theory. Application of such a renormalization technique permits one to derive familiar results for the cross-section despite the fact that the integrals diverge and the matrix elements of the wave-equation in the momentum representation vanish.

539.11

12857 LEE MODEL WITH COMPLEX ENERGY EIGENVALUES. R.Ascoli and E.Minardi.

Nuovo Cimento, Vol. 14, No. 6, 1254-65 (Dec. 16, 1959).

The Lee model with fixed point particles is investigated when complex energy eigenvalues appear in the subspace $(V, N + \theta)$. It is proved that in general such a model has no physical interpretatio at least in the usual framework. Indeed a problem in the subspace $(2V + \theta, V + N + 2\theta, 2N + 3\theta)$ is considered, and it is shown that expressions which are usually interpreted as probabilities become negative. Such difficulties do not appear in simpler problems.

539.1

12858 THE FIELD-THEORETICAL DEFINITION OF NUCLEA POTENTIAL. II. J.M.Charap and S.P.Fubini.

Nuovo Cimento, Vol. 15, No. 1, 73-86 (Jan. 1, 1960).

The results of Pt I (Abstr. 1252 of 1960) are extended to include the exchange forces introduced by charged pions. It is shown that the scattering amplitude for a proton and neutron between which act a potential with an exchange part, is related by symmetrization to that for the scattering of non-identical particles through an isotopic spin dependent potential. This enables the amplitude to be split into two parts, each of which obeys a Khuri-type dispersion relation if the appropriate momentum transfer is kept fixed. The method allow also the generalization of the Mandelstam representation to the case where exchange forces are present. A similar separation of the field-theoretic amplitude is possible into parts which satisfy one-dimensional dispersion relations without the pion singularities for negative energies. A comparison of the dispersion relations and the unitarity condition for the field theoretic amplitudes with those of the potential theory lead to a definition of the potential (which is partly direct, partly exchange) which is capable of simulating the field-theoretic amplitude for energies sufficiently below meson production threshold.

539.11

12859 ANALYTIC PROPERTIES OF l ≠ 0 PARTIAL WAVE AMPLITUDES FOR A GIVEN CLASS OF POTENTIALS.

A.Martin.

Nuovo Cimento, Vol. 15, No. 1, 99-109 (Jan. 1, 1960).

The work of a previous paper (Abstr. 2499 of 1960) on the analytic properties of the S wave amplitude for a family of potential including the Yukawa case is extended to higher waves. Apart from a transformation in order to eliminate the centrifugal term, the method is essentially the same as in the S wave case. It makes use of the Laplace transforms of two quantities related to independent solutions of the Schrödinger equation. The singularities in the upper half complex k plane are bound states on the imaginary axis plus a cut $i(\mu\ 2) \to i\infty$. In any direction (except perhaps the cut)

$$\lim_{|k| \to \infty} S(k) = 1,$$

so it is possible to write dispersion relations.

539.11

12860 FORMULATION OF THE CAUSALITY REQUIREMENT. J.G.Taylor and J.S.Toll.

Nuovo Cimento, Vol. 15, No. 3, 389-94 (Feb. 1, 1960).

The formulation of Segal (Abstr. 2795 of 1958) is considered. This formulation is shown to differ in important respects from the usual requirement of "no output before input" and certain difficultie of physical interpretation are discussed. The formulation is shown to be more restrictive than the usual strict causality and to exclude bound states and certain types of resonances that occur in theories of physical interest. The discussion of the Klein—Gordon wave in terms of the characteristic momentum variable is analysed further and the way in which the formulation leads to a physcially unacceptable extension of the domain of analyticity is described.

539.1

12861 A NEW DERIVATION OF THE STATISTICAL THEORY OF PARTICLE PRODUCTION WITH NUMERICAL RESULTS FOR p—p COLLISIONS AT 25 GeV. R.Hagedorn.

Nuovo Cimento, Vol. 15, No. 3, 434-60 (Feb. 1, 1960).

A new derivation of the statistical model for particle productio is given, starting from S-matrix theory. Though the final formulae are essentially those used already in other recent publications, this derivation shows up clearly where the heuristic arguments come in and which are the weak points. One also sees that, contrary to a widespread opinion, the angular isotropy in the centre-of-mass system is neither a consequence, nor a pre-supposition of the statistical theory; the results of such a theory merely refer to averages over all angles in the c.m.-system. A critical discussion shows, however, that even the present form of the theory applies only to central collisions (in a wide sense) and should be extended non-central ones, if one wishes very detailed data. Arguments e given which show that nevertheless the central collision theory y give agreement with experiments for many interesting quantities experience shows for 2.75 GeV and 6.2 GeV). A more detailed ferentiation of the notion of inelasticity is proposed. Spectra and an production numbers for 25 GeV p—p collisions are given in the m of curves.

539.11

12862 PARITY NONCONSERVING INTERNUCLEON POTENTIALS. R.J.Blin-Stoyle.

ys. Rev., Vol. 118, No. 6, 1605-7 (June 15, 1960).

The general form that a parity nonconserving internucleon ential must take because of invariance requirements is obtained. letailed calculation is then made of the parity nonconserving ential arising from a self-interacting current description of ak interactions. If the polar vector part of the current (J_μ^V) is served, then parity nonconservation of the order 1 part in 10^7 $\cong 10^{-7}$) is to be expected in nuclear processes. Failure to serve such an effect would indicate either that J_μ^V is not conserved that the self-interacting current description is incorrect.

539.11

12863 GENERAL SOLUTION OF THE BETHE—SALTPETER EQUATION IN INSTANTANEOUS INTERACTION PROXIMATION. S.N.Biswas.

ogr. theor. Phys., Vol. 19, No. 6, 725-39 (June, 1958).

For previous work, see Abstr. 9266 of 1960. The Bethe—Salpeter uation is solved for general values of the angular momentum, using ly the ladder approximation and the instantaneous interaction proximation. It is first reduced to a set of coupled equations for singlet and triplet amplitudes, and these are further reduced to corresponding Schrödinger equations. The non-relativistic potenls are deduced and are found to contain automatically a "core" gularity and spin—orbit coupling terms, which are necessary to count for experimental data. The coupling constant, which is the ly adjustable parameter, is fitted to the deuteron binding energy, d the potentials are compared with phenomenological potentials. tisfactory agreement is obtained.

539.11

12864 TWO-PION-EXCHANGE NUCLEAR POTENTIAL. M.Konuma, H.Miyazawa and S.Otsuki.

rogr. theor. Phys., Vol. 19, No. 1, 17-30 (Jan., 1958).

The adiabatic nuclear potential involving the exchange of at ost two pions is derived, the self-pimesic field of each nucleon ing taken into account. Numerical values of this potential are lculated. The limit of the applicability of this potential is examin-, and as a result it is found that this potential can be used in the gion of the inter-nucleon distance $x > \sim 0.7\ \mu^{-1}$ (μ^{-1} = pion mpton wavelength). From the analysis of two-nucleon phenomena, is found that quantitative agreement of the theory with experiment much improved.

539.11

12865 ON THE CONCEPT OF POTENTIAL IN QUANTUM FIELD THEORY. A.Klein.

rogr. theor. Phys., Vol. 20, No. 3, 257-66 (Sept., 1958).

The literature contains two forms of the two-nucleon potential mputed to fourth order in the coupling constant from the gradient upling of the π-meson to the nucleon field. These are commonly ferred to as the Taketani—Machida—Onuma (T.M.O.) potential bstr. 7963 of 1952) and the Brueckner—Watson (B.W.) potential bstr. 1055 of 1954). The merits of the controversy surrounding is schism are re-examined from first principles starting from e covariant equation for two nucleons, and it is concluded that the nditions for the applicability of the method leading to the T.M.O. tential are never satisfied in practice. On the other hand, the W. potential, suitably altered following recent suggestions by iyazawa and the author, may well yield a suitable approximation the low-energy region.

539.11

12866 EFFECT OF THE NON-RELATIVISTIC RECOIL OF A SOURCE PARTICLE IN QUANTUM FIELD THEORIES. Osada and H.Fujino.

rogr. theor. Phys., Vol. 20, No. 4, 487-504 (Oct., 1958).

A calculation method is developed convenient for the treatment polaron-like systems, i.e., the systems of a quantized field and a n-relativistically moving particle which are interacting fairly rongly with each other. Firstly, by generalizing the Chew—Low method, a set of equations are constructed by which one can calculate directly the effect of the recoil of the source-particle on the scattering amplitudes. A formula for the effective mass of the particle is also given. Four problems are solved by this method, as examples. The first two are the scattering of the neutral scalar meson and the effective mass of the polaron; though these have already been solved, they are reinvestigated to explain and justify this approximation method. The last two are the P-wave scattering of the charged scalar meson and of the pair-theory meson. Finally, the importance of the non-relativistic recoil is discussed.

539.11

12867 CHARGED-SCALAR STRONG-COUPLING THEORY. H.Nickle and R.Serber.

Phys. Rev., Vol. 119, No. 1, 449-57 (July 1, 1960).

A treatment of the charged-scalar strong-coupling theory is given which employs a somewhat different choice of variables than that usually used: one which is more convenient for a discussion of the effects of quantum mechanical field fluctuations. The expansion parameter of the strong-coupling theory is shown to be $(1/g^2)\ln(1/Ka)$, where a is the source radius. The isobar energy is calculated to order $1/g^4$, and terms of order $(1/g^2)\ln(1/Ka)$ relative to the leading $1/g^2$ term are found to appear. Similar terms occur in the charge-renormalization factor. The logarithmic term in the isobar energy is found to be precisely that required to renormalize the charge; that is, the isobar energy, if expressed in terms of the renormalized coupling constant, is explicitly independent of the source radius.

539.11

12868 TIME-DEPENDENT IMPULSE APPROXIMATION. S.T.Epstein.

Phys. Rev., Vol. 119, No. 1, 458-60 (July 1, 1960).

The impulse approximation (Abstr. 1332 of 1951; 3301 of 1952) is generalized to cover cases in which a bound system is subject to a time-dependent perturbation. It is shown that the approximation is exact if the perturbation is an impulse. This result supports the supposition that the usual impulse approximation is accurate for collisions in which the collision time is short.

539.11

12869 UNSTABLE PARTICLES IN A GENERAL FIELD THEORY. J.Gunson and J.G.Taylor.

Phys. Rev., Vol. 119, No. 3, 1121-5 (Aug. 1, 1960).

The problem of unstable particles in quantum field theory is treated as one of the interpretation of complex singularities appearing in the analytic continuation of scattering amplitudes into unphysical sheets of their Lorentz invariant variables. Suitable continuations are shown to hold under certain restrictive assumptions in a general field theory, making use of unitarity and causality of the S-matrix. The extra singularities appearing in the continuation are fixed isolated poles, in accordance with a conjecture of Peierls.

539.11

12870 MESON GROUP AND PARITY CONSERVATION. A.Pétermann and H.Ruegg.

Helv. phys. Acta, Vol. 33, No. 2, 143-60 (1960). In French.

A principle of invariance under a continuous local group of transformations, the meson group, is investigated. This principle has the following consequences. (1) for the pseudoscalar Yukawa interaction of two fermions with the pseudoscalar π-meson it entails PC invariance; (2) if the fermions have equal bare masses with respect to electromagnetic interaction (a hypothesis which is plausible for the nucleons), the principle imposes, for the ps interaction with π, the conservation of isotopic spin and separate P and C invariance; (3) for the Fermi interactions of the pairs (pn), (νe^-), etc., it involves V and A coupling, with nonconservation of parity. The arguments leading to this principle are based on a generalization of the demonstration of the Dyson—Foldy equivalence theorem as given by Stueckelberg and Pétermann.

539.11

12871 ON THE STATIC APPROXIMATION OF THE γ_5 MESON THEORY. A.Kanazawa.

Progr. theor. Phys., Vol. 19, No. 3, 330-8 (March, 1958).

The 1/m correction to the static approximation assumed by Sugawara (Abstr. 11104 of 1960) has been estimated within the non-recoil framework in the case of low-energy pion—nucleon scattering. It is here assumed that the Foldy transformation generates a valid static Hamiltonian in the relativistic γ_5-theory. It is shown that two extra parameters appear besides three renormalized coupling constants known thus far in describing S- and P-wave pion—nucleon scattering. However, a crude numerical estimate shows that they may be quite negligible. Another effect of the 1/m correction is to modify the numerical values of the three coupling constants, which would, according to the present rough numerical estimate, not be so great as to invalidate the static approximation assumed by Sugawara.

539.11

12872 ON THE APPLICABILITY OF THE PION-THEORETICAL NUCLEAR POTENTIAL.

S.Otsuki, R.Tamagaki and W.Watari.
Progr. theor. Phys., Vol. 19, No. 2, 217-19 (Feb., 1958).

This is a summary of work in which the nucleon—nucleon cross-section and polarization at 100 MeV were fitted by phase shifts given by the static pion potential. It was found that, by allowing some variation in the mixing parameters and the s- and p-wave phase shifts, to take account of velocity dependence in the inner region, a good fit could be obtained. E.J.Squires

539.11

12873 CONSTRUCTION OF COUPLED SCATTERING AND PRODUCTION AMPLITUDES SATISFYING ANALYTICITY AND UNITARITY.

J.D.Bjorken.
Phys. Rev. Letters, Vol. 4, No. 9, 473-4 (May 1, 1960).

The methods of Omnes and of Chew and Mandelstam for constructing single-channel scattering amplitudes, production amplitudes and vertex functions, on the basis of analyticity and unitarity, are extended to the case of n^2 coupled amplitudes representing the production and scattering among n different channels, with in general different threshold energies. E.J.Squires

539.11

12874 THE WAVE PACKET INTERPRETATION OF SCATTERING.

T.Sasakawa.
Suppl. Progr. theor. Phys., No. 11, 69-116 (1959).

A formal theory of scattering is obtained by considering the development in time of a wave packet incident on a scattering centre, the properties of which are defined by the logarithmic derivative of the wave function at some radius. The relation between the form of the wave packet and the cross-section is discussed, and the conditions for the validity of the usual stationary treatment are derived. These are satisfied in physical problems. The behaviour of the cross-section when suitably averaged over the energy of many sharp resonances is discussed, and the separation into compound elastic and shape elastic scattering made. The latter is shown to be given by a single-particle optical-model potential.

E.J.Squires

539.11

12875 ON PROCESSES INVOLVING TRANSFER OF MOMENTUM TO A MEDIUM.

M.I.Ryazanov.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 854-62 (March, 1960). In Russian.

The change in the transition probability due to Coulomb scattering of charged particles on atoms of a medium is found for a certain class of processes involving a single charged particle and an arbitrary number of neutral particles in the initial and final states.

539.11

12876 SINGULARITIES OF SOME FEYNMAN DIAGRAMS.

V.A.Kolkunov, L.B.Okun' and A.P.Rudik.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 877-81 (March, 1960). In Russian.

The positions of the singularities of two Feynman diagrams are determined.

539.11

12877 STRUCTURE OF THE S-MATRIX IN THE THEORY OF ELASTIC AND INELASTIC SCATTERING OF NON-RELATIVISTIC PARTICLES.

Yu.V.Tsekhmistrenko.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1237-44 (April, 1960). In Russian.

Integral relations for components of the S-matrix describing a two-channel nuclear reaction (one of the channels corresponds to elastic scattering of a nonrelativistic particle and the other to inelastic scattering with excitation of the nucleus) were derived from general principles of causality, unitarity and symmetry. The analytical properties of some S-matrix components were also established. For the sake of simplification the treatment was confined to the case of spherically-symmetrical scattering. In agreement with the resul of Wigner (Abstr. 2572 of 1948) and Baz'(Abstr. 5175 of 1958) the elastic scattering excitation function has a break at the threshold of the inelastic process. The excitation function for the inelastic process near the threshold was found in general form.

539.11

12878 THE ANALYTIC PROPERTIES OF PERTURBATION THEORY. I.

J.C.Polkinghorne and G.R.Screaton.
Nuovo Cimento, Vol. 15, No. 2, 289-300 (Jan. 16, 1960).

A general method is given for locating the complex singularitie of the contributions from Feynman diagrams regarded as functions of the external scalar products. The method is illustrated by application to the third-order vertex function.

539.11

12879 THE ANALYTIC PROPERTIES OF PERTURBATION THEORY. II.

J.C.Polkinghorne and G.R.Screaton.
Nuovo Cimento, Vol. 15, No. 6, 925-31 (March 16, 1960).

The definition of the physical sheet of a perturbation theory function is discussed. The types of singularity near a given surface of singularity are investigated and an expression obtained for the leading singularity. The application of these ideas to the Mandelsta representation and to further problems is indicated.

539.11

12880 RELATIVISTIC WAVE EQUATIONS WITH MAXIMUM SPIN TWO.

T.Tsuneto and I.Fujiwara.
Progr. theor. Phys., Vol. 20, No. 4, 439-56 (Oct., 1958).

The incompleteness of a preceding paper (Abstr. 6393 of 1956) which aimed at extracting tensor equations from the canonical form of relativistic wave equations with maximum spin 2, is removed first by completing the algebraic treatment, using the theory of the rotation group in five dimensions, and then by performing a full analytical reduction into constituent simple fields corresponding to definite values of spin and mass.

539.11

12881 PERTURBATIONAL CALCULATIONS OF PROPAGATO OF THE ELEMENTARY PARTICLES INTERACTING WITH GRAVITATIONAL FIELD.

Y.Miyatake.
Progr. theor. Phys., Vol. 20, No. 4, 476-86 (Oct., 1959).

Expanding Deser's propagators (Abstr. 1485 of 1958) by the coupling constant according to Laurent (Abstr. 2965 of 1957), the propagators are calculated with the gravitational correction by the method of Hu (Abstr. 3337 of 1957). If these corrected propagators are used in the calculations of S-matrices, each Feynman diagram converges except for the cases of vertex number n = 2 correspondin to graviton self-energy due to boson and to graviton—graviton scattering, the former of which may be dropped because of gauge invariance. The larger the degree of the diagram, the better is the convergence.

539.1

12882 ON THE WAVE PROPAGATION IN THE NON-LINEAR FIELDS. II.

T.Taniuti.
Progr. theor. Phys., Vol. 20, No. 4, 529-41 (Oct., 1958).

For Pt I, see Abstr. 10570 of 1959. The general scalar non-linear fields satisfying the Lorentz-covariance are classified into two groups, the semi-linear and the quasi-linear. The singularities on wave fronts are investigated in each case, on the basis of the characteristic theory of partial differential equations.

539.11

12883 APPROACH TO THE QUANTUM MECHANICAL MANY-BODY PROBLEM WITH STRONG TWO-PARTICLE INTERACTION. II.

E.Andersén.
Ark. Fys., Vol. 15, Paper 15, 181-92 (1959).

A previous paper (Abstr. 6652 of 1958) has discussed a variational method using wave functions built up from two-particle wave functions. This is applied to a one-dimensional system of fermions with Gaussian interaction and to a system of four three-dimensiona fermions. The application to the nuclear case is discussed.

539.1

12884 CLUSTER DEVELOPMENT METHOD IN THE QUANTU MECHANICS OF MANY PARTICLE SYSTEM. II. SATURATION OF NUCLEAR FORCES.

F.Iwamoto and M.Yamada.
Progr. theor. Phys., Vol. 18, No. 4, 345-56 (Oct., 1957).

The cluster development method formulated in Pt I (Abstr. 118 of 1959) is applied to the discussion on the saturation of nuclear ces. Serber-type two-body forces with hard cores are assumed which central potentials are assumed to be spin independent. The ential depth and range are determined from the scattering length l the effective range in the spin singlet state, and the hard core lius is taken as $D = 0.6 \times 10^{-13}$ cm. Coulomb forces are neglected. e usual variational method is used with a simple trial correlation ıction. By using the one- and two-nucleon clusters only, the energy nimum per nucleon is found to be -5.2 MeV at $r_0 = 1.1 \times 10^{-13}$ cm. this minimum point the three-nucleon cluster terms are evaluated. ey are one order of magnitude smaller than the leading term, and convergency of the development seems to be fairly good. It is en that the effective potential for the single particle motion in the clear matter is much weakened after separating the short range rrelations between nucleons.

539.11 : 539.2

12885 PERIODIC GROUND STATES AND THE MANY-BODY PROBLEM. E.P.Gross.
ys. Rev. Letters, Vol. 4, No. 12, 599-601 (June 15, 1960).

A general discussion, with references to earlier work, of the ssible existence of ground states with periodic Hartree—Fock ve-functions.

J.Goldstone

539.11 : 539.14

12886 PERTURBATION THEORY APPLIED TO THE NUCLEAR MANY-BODY PROBLEM.
.Levinger, M.Razavy, O.Rojo and N.Webre.
ys. Rev., Vol. 119, No. 1, 230-40 (July 1, 1960).

Perturbation theory is applied to infinite nuclear matter at the served density for a well-behaved two-body potential, containing a ısor force. It is found that a tensor force can contribute as much 10 MeV/particle to the binding energy in second order. Pertur- tion theory is then modified to include the pseudo-potential treat- ent of an infinite repulsive core. A detailed derivation is given of DeDominicis—Martin and Huang—Yang result for a pure repulsive re. An expansion is obtained jointly in powers of the strength of attractive potential, and in the range of the core. The second- der contributions to the binding energy are found for several po- ıtials combining an infinite repulsive core with an attractive po- ıtial. For each case considered, the second-order terms are large bsolute value about 20 MeV/particle).

539.11

12887 TWO-PARTICLE EXCITATIONS OF SUPERFLUID FERMI-SYSTEMS. Yu.V.Tsekhmistrenko.
ı. eksper. teor. Fiz., Vol. 37, No. 4(10), 1164-6 (Oct., 1959). In ıssian. English translation in: Soviet Physics—JETP (New York), ol. 37(10), No. 4, 829-30 (April, 1960).

A method is outlined by which one can obtain the two-particle llective modes by uncoupling the Schwinger equations for the een's functions. The results agree with those of other authors.

D.J.Thouless

ELEMENTARY PARTICLES

539.12

12888 POSSIBLE SPINS FOR ELEMENTARY PARTICLES. F.Engelmann.
ovo Cimento, Vol. 14, No. 6, 1366-72 (Dec. 16, 1959).

It is shown that it is possible to formulate the phenomenological scription of elementary particles in a way which allows the istence of particles of the spins 0, $\frac{1}{2}$ and 1 only. This restriction pears as a consequence of the fact that space-time is 4-dimensional.

539.12

12889 A THEORY OF LEPTON WHICH IS INVARIANT UNDER SPACE INVERSION. K.Sekine.
ogr. theor. Phys., Vol. 19, No. 6, 740-1 (June, 1958).

The four-component equations of the electron and the neutrino d the four-field interaction are written in a form that is invariant der space reflection but accounts for the asymmetry and polar- ıtion of the emitted electrons.

W.A.Hepner

539.12

12890 ON THE HYDRODYNAMICAL THEORY IN MULTIPLE PARTICLE PRODUCTION. M.Hamaguchi.
ogr. theor. Phys., Vol. 19, No. 6, 741-3 (June, 1958).

Using the equations considered in previous papers (Abstr. 2704, 89 of 1957), the strong viscosity effects are discussed.

W.A.Hepner

Photons

539.12

12891 CORRECTIONS TO THE IMPULSE APPROXIMATION FOR PHOTON—DEUTERON SCATTERING.
R.L.Schult and R.H.Capps.
Phys.Rev., Vol. 119, No. 1, 377-80 (July 1, 1960).

The validity of the impulse approximation for the scattering of 50-120 MeV photons from deuterons is investigated by the use of forward scattering dispersion relations. The only significant deviation from the impulse approximation found is in the spin-independent amplitude. Most of this deviation is shown to be the result of the exchange part of the neutron—photon potential. The exchange force is known to increase the electric dipole photo-disintegration cross-section; it is shown that the exchange force also increases the electric dipole elastic scattering cross-section by about 10-20%.

539.12

12892 A SEMIEMPIRICAL METHOD FOR CALCULATING THE ENERGY ABSORPTION BUILDUP FACTOR WITH AN APPLICATION TO A UNIFORMLY CONTAMINATED SPACE HAVING SPHERICAL BOUNDARIES. K.O'Brien, W.M.Lowder and L.R.Solon.
Nuclear Sci. Engng, Vol. 3, No. 1, 77-84 (Jan., 1958).

A form for the point-source gamma-ray energy absorption buildup function valid for a material in the energy range where it is essentially a Compton scatterer is suggested as a modification of the asymptotic forms derived by Fano. Its parameters are evaluated by means of an energy equilibrium condition and a fit to experimental data. The results are compared with those obtained by other methods and an application to the problem of uniformly and continuously distributed point sources is discussed.

539.12

12893 PERMISSIBLE VOIDS IN PHOTON SHIELDS. D.G.Chappell.
Nuclear Sci. Engng, Vol. 6, No. 2, 140-6 (Aug., 1959).

Permissible void volume in photon shields is calculated in terms of shield thickness, photon energy, and permissible leakage factor. Several graphical aids for lead are presented. A simple method of void evaluation is included which may form the basis for an engineering acceptance test.

539.12

12894 SCINTILLATION PAIR SPECTROMETER FOR γ-RAYS OF ENERGY UP TO 20 MeV. J.P.Longequeue.
J. Phys. Radium, Vol. 20, Suppl. No. 4, 37A-40A (April, 1959). In French.

A scintillation pair spectrometer was built in order to measure the energy of γ-rays given by (p,γ) reactions This spectrometer proved capable of measuring energies in the range from 2 to 20 MeV. Its resolution is 6.5 ± 0.5% at 6.1 MeV; and its efficiency varies from 2×10^{-4} to 1.7×10^{-3}, between 2 and 20 MeV.

539.12

12895 MEASUREMENT OF THE GAMMA-RAY DOSE NEAR THE INTERFACE BETWEEN TWO MEDIA. F.Titus.
Nuclear Sci. Engng, Vol. 3, No. 5, 609-19 (May, 1958).

Measurements have been made of the distribution of exposure dose in the neighbourhood of a plane boundary separating two media of very different density, steel-wool and steel. A point-isotropic Co^{60} source was located in the vicinity of the boundary. Control measurements were performed in a homogeneous medium of steel-wool. In this way the effect on gamma-ray propagation of an abrupt density change was established. The main result was a progressive decrease of exposure dose near the density-interface compared with the homogeneous medium situation, as the source-detector distance was increased. There is good agreement between the experimental results and corresponding Monte Carlo calculations.

539.12

12896 BREMSSTRAHLUNG CROSS SECTION AT THE SHORT-WAVE LIMIT. M.V.Mihailović.
"J. Stefan" Inst. Rep., Vol. 5, 137-44 (Oct., 1958).

The differential cross section (for forward direction) per unit energy interval of the photon at the high-energy end is calculated using the Sommerfeld—Maue functions for both ingoing and outgoing electrons. An estimate of error shows that the result is excepted to be satisfactory for $Z \leq 42$.

539.12

12897 ENERGY—ANGLE DISTRIBUTION OF BREMSSTRAHLUNG SPECTRUM. M.Vakselj and N.Bezič.

"J. Stefan" Inst. Rep., Vol. 5, 9-11 (Oct., 1958).

The differential bremsstrahlung cross-section of Bethe and Heitler is integrated over scattered electron angles to obtain the energy—angle distribution of the bremsstrahlung spectrum. The integration has been carried out exactly by an analytic approximation for the Hartree field of the atom, giving a better approximation than the Thomas—Fermi field, especially for low values of q.

539.12 : 539.17

12898 EMISSION OF BREMSSTRAHLUNG BY FISSION FRAGMENTS. A.I.Alekseev.

J. nuclear Energy, Vol. 9, No. 1-4, 248-50 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 465 (1958).

It is shown that the main part is emitted within a Bohr radius of the parent atom, before the fragments have been able to pick up orbital electrons. The calculation is classical because the de Broglie wavelength of the fragments is small compared to this Bohr radius. The total energy radiated (dipole radiation) is:

$$E = \frac{16}{45}\left(\frac{Z_1}{A_1} - \frac{Z_2}{A_2}\right)\left(\frac{2A_1A_2}{A_1 + A_2}\right)^{1/2}\left(\frac{E}{mc^2}\right)^{5/2}\frac{mc^2}{Z_1Z_2}$$

where E is the kinetic energy of the fragments, m the nucleon mass and A_1, A_2, Z_1, Z_2 are mass numbers and charges of the fragments. If these are nearly equal the quadrupole radiation of magnitude

$$E_{\text{quad}} = \frac{16}{1575}\left(\frac{Z_1}{A_1^2} + \frac{Z_2}{A_2^2}\right)^2\left(\frac{2A_1A_2}{A_1 + A_2}\right)^{3/2}\left(\frac{E}{mc^2}\right)^{7/2}\frac{mc^2}{Z_1Z_2}$$

must be taken into account. H.Motz

539.12

12899 HIGH-ENERGY BREMSSTRAHLUNG FROM A SILICON SINGLE CRYSTAL.

G.Bologna, G.Diambrini and G.P.Murtas.

Phys. Rev. Letters, Vol. 4, No. 11, 572-5 (June 1, 1960).

Measurements were made of the intensity of the bremsstrahlung produced in a single crystal of silicon by electrons of energy ~ 1 GeV, as a function of the angle between the electron beam and the crystal axis [111]. The results are similar in form to the predictions of Überall (Abstr. 461, 7964 of 1957). In particular the central minimum is clearly observed whereas previous experiments have not had the resolution to show it. A.Ashmore

539.12 : 539.16

12900 THE INTERNAL BREMSSTRAHLUNG IN β-DECAY OF POLARIZED NUCLEI.

Chin Chen-Zhui [Ch'ing Ch'eng-Jui] and F.Janouch.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 948-51 (March, 1960).

The internal bremsstrahlung in β-decay of polarized nuclei is considered. The general form of angular distributions is given. It is shown that measurement of the correlation between the direction of emission of the internal-bremsstrahlung quanta and the direction of polarization of nuclei provides information on the form of β-interaction.

539.12

12901 ABSOLUTE INTENSITY MEASUREMENT OF HIGH-ENERGY γ-RAYS BY THE PAIR DIFFERENCE METHOD.

I.N.Usova.

Zh. tekh. Fiz., Vol. 30, No. 6, 665-71 (June, 1960). In Russian.

The intensity of bremsstrahlung of 260 MeV maximum energy from the electron synchroton at the Physical Institute of the Academy of Sciences, Moscow, was measured by the pair difference method due to Blocker et al. (Abstr. 8976 of 1950) and also using a thick-walled graphite chamber. The former method appeared to give twice as large a result, but the discrepancy is resolved here by taking account of energy variation of the photoeffect, and multiple scattering of electrons in the converter. D.W.L.Sprung

539.12

12902 ON THE THEORY OF SOME ČERENKOVIAN EFFECTS. G.Toraldo di Francia.

Nuovo Cimento, Vol. 16, No. 1, 61-77 (April 1, 1960).

The field generated by a charged particle in uniform straight motion is expanded into a set of evanescent waves. The expansion is valid in any half-space with no points in common with the path of the particle. The evanescent waves may impinge on the surface of an optical diffraction grating and be diffracted. Some of the diffracted waves turn out to be ordinary plane waves, which carry energy away from the grating. It is possible in this way to explain the Smith and Purcell effect and to derive some quantitative conclusions.

539.12

12903 CHERENKOV RADIATION OF A PARTICLE POSSESSING A CHARGE AND AN INTRINSIC MAGNETIC MOMENT. Li Men Kha [Li Meng Ha].

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 934-6 (March, 1960).

The effect of spin on the radiation intensity and polarization of a particle possessing a charge and an intrinsic magnetic moment in a ferromagnetic dielectric is studied by quantum-electrodynamic methods. An analysis of the radiation near the threshold is presente

X-rays

539.12

12904 SPECTRAL DISTRIBUTIONS OF SCATTERED X-RAYS AT POINTS LYING OFF THE BEAM AXIS.

S.Mak and D.V.Cormack.

Brit. J. Radiol., Vol. 33, 362-7 (June, 1960).

The modification of a scintillation spectrometer so that it may may be rotated about two mutually perpendicular axes is described. The apparatus greatly simplifies measurements of scattered spectra which do not lie on axes of radial symmetry. The scattered spectra at points at the centre and near the edge of beams of 140 and 280 kVp radiation were measured. These spectra were then integrated to obtain the spectrum incident from all angles. The results were compared with those calculated using a Monte Carlo method. C.F.Barnaby

539.12

12905 SPECTRAL DISTRIBUTIONS OF PRIMARY AND SCATTERED 140-Kvp X-RAYS.

D.V.Cormack and D.G.Burke.

Radiology, Vol. 74, No. 5, 743-52 (May, 1960).

Considers the primary and scattered radiation spectra from a Picker Vanguard X-ray machine operating at 140 kVp. The half-value layer calculated from the primary spectrum was 1.45 ± 0.1 mm Al as compared with the measured value of 1.33 ± 0.1 mm Al. Scattered spectra were measured in water on the central axes of circular fields 50 and 300 cm^2 in area and at depths of 2, 5 and 10 cm. The complete scattered spectra was obtained by integrating graphically measurements made at angles between 15° and 140°. Primary and scattered spectra were normalized to an incident primary dose of 100 r with the aid of published depth dose data. Effective half-value layers of primary, scattered, and total radiation are tabulated. C.F.Barnaby

Neutrinos

539.12

12906 EFFECTS OF THE PAULI PRINCIPLE ON THE SCATTERING OF HIGH-ENERGY ELECTRONS BY ATOMS. M.H.Mittleman and K.M.Watson.

Ann. Phys. (New York), Vol. 10, No. 2, 268-79 (June, 1960).

Some consequences of the Pauli principle for the elastic scattering of electrons by atoms are studied. The contributions both from the exchange integrals and from the Hartree—Fock condition that the scattered wave be orthogonal to the bound-state wave functions are expressed in a simple approximate form. For high-energy electrons these corrections are very small.

539.12

12907 A NOTE ON THE WATANABE THEORY OF WEAK INTERACTIONS. A.Vančura.

Czech. J. Phys., Vol. 10, No. 1, 28-32 (1960).

It is shown that according to the Watanabe theory of weak interactions a resonant scattering of electrons by protons must take place. The resonant energy depends on the mass m_B of the intermediate boson. For $m_B = 2300\ m_e$, this energy is about 213 MeV in the centre of mass system. The energy width at resonance is 1.4 MeV.

539.12

12908 RADIATIVE CORRECTIONS TO COULOMB SCATTERING WITH ALLOWANCE FOR THE MEDIUM.

L.Ter-Mikaelyan.
. eksper. teor. Fiz., Vol. 38, No. 4, 1167-9 (April, 1960).
Russian.

Radiative corrections to electron scattering are treated with owance for the "density effect". Under certain conditions the rrections due to the medium become important and are given in paper.

539.12

12909 EFFECT OF VACUUM FLUCTUATIONS ON THE POLARIZATION OF ELECTRONS MOVING IN A AGNETIC FIELD. I.M.Ternov and V.S.Tumanov.

. eksper. teor. Fiz., Vol. 37, No. 4(10), 1137-9 (Oct., 1959). In ssian. English translation in: Soviet Physics—JETP (New York), l. 37(10), No. 4, 809-10 (April, 1960).

Quantum field theoretical methods are applied to the problem ated by Mendlowitz and Case (Abstr. 1901 of 1955), the validity the results being extended to electrons of arbitrary energy, the eraction with the photon vacuum being included. J.Hawgood

ctrons

539.12 : 537.54

COHERENT RADIATION OF ELECTRONS IN A SYNCHROTRON.

Abstr. 12662

539.12

12910 POLARIZATION EFFECTS IN THE SCATTERING OF ELECTRONS ON DEUTERONS. G.V.Frolov.

. eksper. teor. Fiz., Vol. 38, No. 4, 1148-52 (April, 1960).
Russian.

The differential cross-section and change in the electron polari-tion which occurs when polarized deuterons are disintegrated by larized electrons are calculated with allowance for electromag-tic nucleon form-factors. An expression is also derived for the larization of recoil deuterons in elastic scattering of polarized ectrons on unpolarized deuterons.

539.12 : 539.1.07

12911 THE IONIZATION AT THE ORIGIN OF A HIGH-ENERGY ELECTRON—POSITRON PAIR. A.A.Varfolomeev,

I.Gerasimova, L.A.Makarjina, A.S.Romantzeva and S.A.Chueva. Particle photography" Conference. Montreal, 1958 (see Abstr. 61 of 1960) p. 431-9. In French.

The reduction in the ionization in the immediate neighbourhood the origin of a high-energy pair due to the mutual screening fect of two electric fields can be used in conjunction with the ening angle of the pair to estimate the energy of the primary antum. The results of measurements of the grain density and the ean gap length over track lengths of several mm on five electron—sitron pairs with energies exceeding 3×10^{11} eV are given, and e presence of the screening effect noted in three cases. The sults are in accord with the theoretical predictions.
S.J.St-Lorant

539.12

12912 ELECTRON PAIR PRODUCTION IN $\pi^- + d$ CAPTURE.

D.W.Joseph.
ys. Rev., Vol. 119, No. 2, 805-10 (July 15, 1960).

The internal conversion coefficient $p(p) = (dW_{2e}/dp)/(dW_\gamma/dp)$ lating the $\pi^- + d$ capture processes yielding $2n + e^+ + e^-$ and $+ \gamma$ is calculated as a function of the n—n relative momentum p. is found to be a slowly varying function of p, insensitive to the rength of the n—n force. The spectrum of the electron pair energies r of the momentum p), therefore depends sensitively on the n—n attering length, just as Watson and Stuart (Abstr. 5739 of 1951) und to be the case for the photon spectrum. Thus, observation of e pair production process is an alternative method of measuring e n—n scattering length.

539.12

12913 PRODUCTION OF AN ELECTRON—POSITRON PAIR BY A NEUTRINO IN THE FIELD OF A NUCLEUS.

M.Badalyan and Chzhou Guan-chzhao [Chou Kuang-chao].
. eksper. teor. Fiz., Vol. 38, No. 2, 664-5 (Feb., 1960). In ssian.

The possibility of observing production of an electron—positron pair by a neutrino is discussed. The differential cross-section is strongly peaked in the forward direction at high energies. In the field of a fairly heavy nucleus, this process should have a larger cross-section than that of electron—neutrino elastic scattering above about 10 MeV. D.J.Thouless

Nucleons

539.12

12914 A FREE NUCLEON THEORY.

R.L.Ingraham.
Nuovo Cimento, Vol. 16, No. 1, 104-27 (April 1, 1960).

A theory of the free nucleon quantum field based on the spin $\frac{1}{2}$ wave equation proposed by Murai is given. Notable features are: (1) the nucleon field is an (8-dimensional) irreducible representation of its fundamental group, the 15-parameter group of all angle-preserving transformations of space-time; (2) in spite of non-vanishing mass this nucleon possesses a new quantum number β_7', the invariant handedness; neutron and proton can be distinguished by $\beta_7' = -1$ and $+1$, and the charge operator can be introduced as the generator of the symmetry group $\Psi' = \exp[i\alpha(\beta_7' + 1)/2]\Psi$; (3) the bare nucleon necessarily has a mass spectrum; mass is conjugate to another measurable length λ associated with a nucleon, and states can be formed in which the unsharpness of the bare mass and of λ vary in a complementary way. The relevance of this new concept to the physical process of measuring the mass via interaction with other fields and to the renormalization of this nucleon field is discussed.

539.12

12915 ELECTROMAGNETIC FORM FACTORS OF THE NUCLEON. F.J.Ernst, R.G.Sachs and K.C.Wali.

Phys. Rev., Vol. 119, No. 3, 1105-14 (Aug. 1, 1960).

The physical interpretation of the electromagnetic form factors is discussed with special reference to the gauge invariance of particular theories. A distinction is made between the condition that the one nucleon matrix element satisfy the equation of continuity ("weak gauge invariance") and the stronger condition imposed by the generalized Ward identity ("strong gauge invariance"). The former is shown to be a consequence of covariance under the improper Lorentz transformations, and hence it has no new content concerning the functional behaviour of the form factors. The latter implies restrictions on the current operator which may have an important effect on the results of calculations of form factors. In connection with the physical interpretation, it is noted that the moments of the charge and current distribution are determined by $F_{ch} = F_1 - (q^2/2M)F_2$ and $F_{mag} = (1/2M)F_1 + F_2$. Specifically the second moment of the charge distribution, $-6F_{ch}'(0)$, is found, in the case of the neutron, to be directly measured by the neutron—electron interaction without the intervening subtraction of the Foldy term. These matters are investigated in detail by means of a specific model of the nucleon which is a covariant generalization of the fixed source static model having the property that it gives results identical with the static model in the limit $M \to \infty$. It is found that strong gauge invariance requires the addition of line currents which make significant contributions to the form factors in general and, in particular, to the proton charge radius even in the static approximation. This suggests that as a consequence of strong gauge invariance, important contributions to the charge radius must arise in any theory from intermediate states of large mass. The model also provides a means of consistently calculating recoil corrections to the static model. They are found to be large.

539.12

12916 ELECTROMAGNETIC PROPERTIES OF NUCLEONS.

A.Kanazawa, S.Furui and T.Sakuma.
Progr. theor. Phys., Vol. 20, No. 2, 149-62 (Aug., 1958).

The current and the magnetic moment of the nucleon are calculated, starting from a relativistic one nucleon formalism. It is shown that the relativistic corrections are very important for the current and the magnetic moment, especially for the vector part of the former and the scalar part of the latter, where the effects of the recoils are of the same order as those given by the static model. The numerical result, obtained by means of Chew's method, shows that the neutron current and the scalar part of the magnetic moment may be consistent with the experiment by choosing suitably the coupling constant ($g^2/4\pi = 0.08$ or 0.10) and the cut-off momentum ($k_{max} = 5\mu$, 6μ or 7μ). However the effect of the nucleon recoil to the vector part of the moment is destructive and gives a definitely smaller value than the empirical one. It is also shown that the renormalized charge is equal to the unrenormalized charge in this approximation which contains only the terms up to the order of 1/M.

539.12

12917 EFFECTS OF VIRTUAL NUCLEON PAIRS TO THE ELECTROMAGNETIC STRUCTURE OF THE NUCLEON.

S.Goto and S.Machida.
Progr. theor. Phys., Vol. 20, No. 2, 216-38 (Aug., 1958).

The effects of virtual nucleon pairs on the electromagnetic structure of the nucleon are calculated covariantly in the charge independent pseudoscalar meson theory. A rigorous expression for the vertex operator is derived which is very similar to first- and second-order perturbation theory. The method of approximation used is to replace the complete set of eigenfunctions of the total Hamiltonian by some suitable functions, which are chosen so as to take into account the main contribution from the virtual nucleon pairs. These effects are proved, regardless of the magnitude of the coupling constant, to reveal themselves only through the renormalization factors, which affect the relative magnitudes of the isotopic scalar and vector parts of the nucleon-current contributions and the meson-current contributions. Numerical results are almost the same as those obtained by cutting off the momentum integration at the nucleon mass in the second-order perturbation calculation both for the ratio of the anomalous magnetic moments of the proton and the neutron and the mean-square radii of the charge distributions.

539.12

12918 A REMARK ON THE ANOMALOUS MAGNETIC MOMENT IN THE STATIC MODEL.

Y.Hara and K.Kawarabayashi.
Progr. theor. Phys., Vol. 20, No. 2, 252-4 (Aug., 1958).

The static model pion—nucleon interaction Hamiltonian includes a term preserving guage invariance. Assuming an extended source nucleon with cut-off at high momenta, the magnetic moment anomaly due to this term is computed by a method of Miyazawa (Abstr. 2679 of 1956). A large value is found which would cancel the reasonable values found neglecting this term. Reasons are advanced for doing so. D.W.L.Sprung

539.12

12919 DISPERSION RELATIONS IN NUCLEON—NUCLEON SCATTERING. S.Matsuyama and H.Miyazawa.

Progr. theor. Phys., Vol. 18, No. 3, 328-9 (Sept., 1957).

The nucleon—nucleon dispersion relation for the forward scattering amplitude is written down. It is observed that one of the terms which occurs is proportional, in the static limit, to the nucleon—nucleon potential. D.J.Thouless

539.12

12920 DISPERSION RELATIONS IN NUCLEON—NUCLEON SCATTERING. S.Matsuyama and H.Miyazawa.

Progr. theor. Phys., Vol. 19, No. 5, 517-33 (May, 1958).

The dispersion relation of Kronig and Kramers is applied to the case of nucleon—nucleon scattering. The real part of its forward scattering amplitude is expressed in terms of an integral of the total cross-sections and an integral of the imaginary part over the unphysical region. It is shown that the latter is, in the static limit, proportional to the Fourier transform of the nuclear potential. This furnishes a new method of determining the shape of the nuclear force potential from experimental data.

539.12

12921 PERIPHERAL INTERACTION OF NUCLEONS IN THE TWO-MESON APPROXIMATION.

A.F.Grashin and I.Yu.Kobzarev.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 863-9 (March, 1960).
In Russian.

Triplet phase-shifts in nucleon—nucleon scattering were computed in the two-meson approximations for nonrelativistic energies. Comparison of the two-meson and one-meson phase-shifts showed that the one-meson approximation is very exact for all mixing parameters (beginning from ^3S—^3D). This permits the use of theoretical mixing parameter values in phase analysis for choosing the unique solution. The peripheral part of the two-meson potential, corresponding in the first Born approximation to the scattering amplitude, was also derived.

539.1

12922 MULTIPLE PRODUCTION OF JET PARTICLES IN PERIPHERAL COLLISIONS.

Yu.A.Romanov and D.S.Chernavskii.
Zh. eksper. teor. Fiz., Vol. 38, No. 4 1132-9 (April, 1960).
In Russian.

Peripheral collisions of high-energy nucleons ($E_{lab} > 10^{13}$ eV) are considered. The Weizsäcker—Williams method is employed an thus one can classify peripheral collisions and describe the peculiar ties of each type of interaction. One of the simplest variants (peripheral single-meson interaction) is calculated by perturbation theo methods.

Protons

539.12 : 539.1.0

CONSTANT SAGITTA MEASUREMENTS ON PROTONS IN G5, K5 AND L4 EMULSIONS. See Abstr. 12776

539.1

12923 SOME CHARACTERISTICS OF INELASTIC PROTON—NUCLEON COLLISIONS PRODUCED BY PROTONS OF ENERGY 6.2 GeV IN NUCLEAR EMULSIONS.

R.R.Daniel, N.Kameswara Rao, P.K.Malhotra and Y.Tsuzuki.
Nuovo Cimento, Vol. 16, No. 1, 1-25 (April 1, 1960).

Nuclear interactions produced by protons of energy 6.2 GeV in nuclear emulsions have been analysed to deduce information regarding some of the characteristics of proton—nucleon collisions. 703 disintegrations have been obtained by "along the track" scannin Accurate measurements of multiple scattering and of grain density have been made on favourable tracks of relativistic secondary particles; using these measurements it has been possible to identif the particles up to the highest energies involved. It is found from this investigation that in collisions of protons of energy 6.2 GeV wi nucleons: (a) the mean charged pion multiplicity is 1.51 ± 0.18; (b) the mean inelasticity is 0.43, and is, within errors, independent of the total multiplicity n_g; (c) the nucleons recoiling in the c.m. system are very strongly collimated symmetrically in the forward and backward directions; (d) the mesons created in the collision als show an appreciable amount of forward—backward collimation in th c.m. system.

539.1

12924 PROTON AND ANTIPROTON DIFFRACTION SCATTERING ON COMPLEX NUCLEI. G.Baroni, G.Bellettini, C.Castagnoli, M.Ferro-Luzzi and A.Manfredini.

Nuovo Cimento, Vol. 15, No. 1, 1-6 (Jan. 1, 1960).

A comparison of the results on antiproton and proton diffractio scattering on emulsion nuclei is carried out on the basis of 26.4 m proton track with E = 125 MeV, and 23.15 m of antiproton track wit E = 150 MeV. A disagreement is shown to exist between experimen and optical model calculations at 140 MeV.

539.1

12925 PROTON—PROTON SCATTERING AT 68 MeV. D.E.Young and L.H.Johnston.

Phys. Rev., Vol. 119, No. 1, 313-15 (July 1, 1960).

Differential cross-sections were measured for the scattering 68.3 MeV protons by hydrogen gas at 26 laboratory angles from 5° to 50°. The angular resolution was $\pm\frac{1}{2}^{\circ}$ at small angles, and the est mated absolute probable errors are ±0.9% except at the smallest angles. The interference minimum of 5.19 millibarns occurs at 16.3° c.m. The cross-section then rises to a maximum of 6.33 mb a 34° and falls to 6.16 mb at 90°.

539.1

12926 DEPOLARIZATION AND TIME REVERSAL IN p—p SCATTERING AT 142 MeV.

C.F.Hwang, T.R.Ophel, E.H.Thorndike and R.Wilson.
Phys. Rev., Vol. 119, No. 1, 352-61 (July 1, 1960).

The depolarization was measured at angles from 6° to 40° in t laboratory system. The measurements were made by scattering a 67% polarized proton beam first off a liquid hydrogen target, then a carbon (or lithium) analyser. The scattered protons were detect by plastic scintillation counters, and the asymmetries from the las scattering were measured at each hydrogen scattering angle. The angular dependence of depolarization determined in this work was similar to that measured at 315 MeV by other workers. The data

agree with other measurements at 143 MeV By measuring on
n sides of the beam, the polarization in scattering is determined
compared with asymmetry in scattering from a polarized beam.
ir equality confirms time reversal invariance in the proton—
ton interaction.

539.12

12927 **PROTON—PROTON DEPOLARIZATION AT 98 MeV.** E.H.Thorndike and T.R.Ophel.
s. Rev., Vol. 119, No. 1, 362-5 (July 1, 1960).
The triple scattering depolarization parameter D for p—p
ttering was measured at 98 MeV, as follows: 10^0 (lab),
$) \pm 0.08$; 15^0, 0.00 ± 0.07; 20^0, 0.00 ± 0.08; 25^0, -0.12 ± 0.10; 30^0,
11 ± 0.16.

539.12

12928 **SMALL-ANGLE PROTON—PROTON SCATTERING AT 435 MeV.** S.K.Kao, H.Horstman and G.W.Hinman.
s. Rev., Vol. 119, No. 1, 381-4 (July 1, 1960).
Scattering cross-sections were measured in the angular range
20^0 (centre of mass). An ionization chamber was used to measure
direct beam and the scattered protons were detected by means
photographic plates. The results are substantially in agreement
h other work in the range of energy and angle, although there is
ne indication of a slight minimum in the curve at the edge of the
ulomb region.

539.12

12929 **PROTON—PROTON SCATTERING AND PION THEORY OF NUCLEAR FORCES.** S.Otsuki.
gr. theor. Phys., Vol. 20, No. 2, 171-80 (Aug., 1958).
p—p scattering at 90 MeV is discussed. No evidence is found
how that the static pion-theoretical potential is appreciably
dified up to 100 MeV. This conclusion is in conflict with the
diction of very strong spin—orbit coupling potentials recently
de by Signell and Marshak and by Gammel and Thaler. Especially,
s noted that the former spin—orbit term was introduced in accord-
e with Gartenhaus' potential at small inter-nucleon distances.
ese spin—orbit coupling potentials are unreasonably strong from
pion-theoretical viewpoint. The importance of the $^3P_2-^3F_2$
pling parameter in determining angular distributions is pointed
See also following abstract.

539.12

12930 **NEUTRON—PROTON SCATTERING AND PION THEORY OF NUCLEAR FORCES.** W.Watari.
gr. theor. Phys., Vol. 20, No. 2, 181-91 (Aug., 1958).
n—p scattering at 90 MeV is discussed. Around this
rgy, phase shifts with $L \geq 2$ are almost completely determined
the one-pion-exchange potential. Phase shifts with $L = 1$ should
qualitatively determined by the pion theory. Phase shifts with
0 must be determined phenomenologically. In this paper, using
wave phase shifts obtained by Otsuki from the p—p scattering
a (see preceding abstract) scattering parameters are determined.
he ($J = 1$)-states from the n—p scattering analysis. n—p polar-
tions are analysed and some sets of phase shifts with $J = 1$ which
consistent with the experiments are determined. Using the
se shifts thus determined, angular distributions are calculated
compared with experimental data. It is found that the static
n-theoretical potential can reproduce n—p experimental data
0 MeV without any serious modifications.

539.12

12931 **MODIFIED ANALYSIS OF NUCLEON—NUCLEON SCATTERING p—p PHASE SHIFTS AT 210 MeV.**
H.MacGregor and M.J.Moravisik.
s. Rev. Letters, Vol. 4, No. 10, 524-7 (May 15, 1960).
Reports a phase-shift analysis of the experimental values of
P, R and A for p—p scattering at 200 MeV. The G and higher
se shifts were taken from the one pion exchange potential, and
best values of the others were found. The expected value of
was 26, and seven sets of phase shifts were found with χ^2 less
n 200. All these can be ruled out with certainty by other argu-
nts (mainly by comparison with results at 300 MeV) except two:
$= 28$ and 56, which correspond to Stapp solutions 1 and 2
pectively. Experiments to distinguish between these possibilities
suggested. E.J.Squires

539.12

2932 **RESULTS OF A MODEL OF THE p—p INTERACTION AT 10 GeV.** G.I.Kopÿlov.
eksper. teor. Fiz., Vol. 36, No. 5, 1598-1600 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1136-7 (Nov., 1959).

Using a statistical model (Abstr. 12535 of 1959), a table of 200 random stars in p—p interactions at 10 GeV was made. Results are given for momentum distributions of nucleons and mesons and for the spectrum of angles between rays of the star. A.Ashmore

539.12

12933 **INTERACTION BETWEEN 630 MeV PROTONS AND He^4 NUCLEI.** M.S.Kozodaev, M.M.Kulyukin, R.M.Sulyaev, A.I.Filippov and Yu.A.Shcherbakov.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 708-15 (March, 1960). In Russian.

A high-pressure diffusion cloud chamber was employed to study scattering of 630 MeV protons on helium nuclei. The total, elastic and inelastic cross-sections were measured and found to equal respectively $(150 \pm 13) \times 10^{-27}$ cm^2, $(24 \pm 5) \times 10^{-27}$ cm^2 and $(126 \pm 14) \times 10^{-27}$ cm^2. The angular distribution for elastic scattering can be satisfactorily described by the optical model with a complex potential with $V_R = 30$ MeV, $V_I = -(34 \pm 4)$ and $R = 1.45 \times \times 10^{-13}$ cm. Quasi-elastic proton—proton scattering and quasi-free proton—neutron interaction were singled-out. The cross-sections for these reactions were $(15 \pm 2) \times 10^{-27}$ cm^2 and $(24 \pm 2) \times 10^{-27}$ cm^2 per nucleon. It is demonstrated that in 20% of the events a cascade develops or the primary particle experiences a collision with a group of nucleons. Events involving π^--meson creation in p—n collisions were treated separately and it was established that the cross-section for this process is $(1.3 \pm 0.5) \times 10^{-27}$ cm^2 per neutron.

539.12

12934 **THE pn → pnπ^0 REACTION IN THE ENERGY RANGE FROM THE THRESHOLD UP TO 665 MeV.**
A.F.Dunaitsev and Yu.D.Prokoshkin.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 747-57 (March, 1960). In Russian.

By a simultaneous investigation of π^0-meson production in pd- and pp-collisions, information is obtained on the magnitudes of the total cross-sections and angular distributions for the reaction pn → pnπ^0 in the energy region from the threshold up to 665 MeV. Comparison of these cross-sections with those of other reactions shows that the condition imposed on the relation between the total cross-sections of various meson-production reactions by the isotopic invariance hypothesis is fulfilled (to within 10%) in the investigated energy region. Production of π-mesons in a state with an isotopic spin $T = 1$ is about twice as intense as that in states with $T = 0$. The angular distribution of π^0-mesons produced in nucleon—nucleon collisions at an energy of about 650 MeV was found to be approximately isotropic, in contrast to that of the charged pions which is essentially anisotropic. This difference contradicts the hypothesis of the isotopic invariance.

539.12

12935 **PARTICLE PRODUCTION IN 6.2 GeV p—p COLLISIONS TREATED BY A STATISTICAL MODEL.** R.Hagedorn.
Nuovo Cimento, Vol. 15, No. 2, 246-68 (Jan. 16, 1960).

The Fermi theory of particle production is used in a rigorous and refined form in order to calculate spectra and mean particle numbers for all particles produced (i.e. N, π, $\bar{N}$ and strange particles) in 6.2 GeV (kin. lab.) p—p collisions.

539.12

12936 **SOME CHARACTERISTICS OF THE ANNIHILATION OF AN ANTIPROTON IN THE DEUTERON.** É.O.Okonov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1597-8 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1134-6 (Nov., 1959).

It is pointed out that during capture of p$^-$ by a deuteron several possible two-body final states exist, e.g.

$$p^- + d \rightarrow p + \pi^0,$$
$$p^- + d \rightarrow n + \pi^+.$$

The cross-sections for these processes are linked by charge independence and should be in the ratio 2 : 1. Similar reactions involve two strange particles in the final state, and study of these should provide a check on the correctness of the concept of charge independence and/or the assignments of isotopic spin to the strange particles. S.J.Goldsack

Neutrons

539.12

12937 MEASUREMENT OF THE NEUTRON HALF-LIFE.

A.N.Sosnovskii, P.E.Spivak, Yu.A.Prokof'ev, I.E.Kutikov and Yu.P.Dobrynin.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1012-18 (April, 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 717-21 (Oct., 1959).

The protons were accelerated with an electrode at a distance of about 80 cm from the neutron beam so as to avoid having to know the form of the proton spectrum. A series of diaphragms was used to define the aperture for proton collection. Transmission through these diaphragms was estimated to be 0.843 ± 0.006. The neutron-beam density was determined using activation of gold foils and of a sodium target. Density distribution across the beam was found by cutting one of the activated gold foils into 900 squares. The central neutron density was found to be $2.17 \times 10^3 \pm 1.8\%\ \mathrm{cm}^{-3}$ and the integral of neutron density $(7.68 \pm 0.15) \times 10^4\ \mathrm{cm}^{-1}$. A CF_4 proportional counter was used to count the protons. The number of counts was corrected for background and for H^+ ions from the walls. The corrected value for the number of protons was $35.6 \pm 0.54\ \mathrm{min}^{-1}$ giving a half-life of 11.7 ± 0.3 min and an ft value of 1180 ± 40 which is, within the error, the same as that of H^3. Comparison with O^{14} gives $G^2_{GT}/G^2_P = 1.42 \pm 0.08$. A.Ashmore

539.12

12938 ADDITION TO THE PAPER "THEORY OF THE β-DECAY OF NEUTRONS.

S.M.Bilen'kii, R.M.Rȳndin, Ya.A.Smorodinskii and Khé Tszo-Syu [Ho Tso Hsiu].

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 1013 (March, 1960).
In Russian.

Formula (12) of this paper (Abstr. 7349 of 1960) is re-written, making explicit the absence of V—A interference in agreement with a theorem of Weinberg (Abstr. 330 of 1960). D.W.L.Sprung

539.12

12939 ON THE INFLUENCE OF THE ISOBARIC STATE OF A NUCLEON ON THE ELECTRON—NEUTRON INTERACTION.

G.A.Kharadze.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1577-8 (May, 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1119-20 (Nov., 1959).

Qualitative estimates, for the root-mean-square electric radius of the nucleon and the potential well depth of the electrostatic electron—neutron interaction, were obtained by considering the influence of isobaric states, in particular the $T = J = 3/2$ resonance in the meson—nucleon interaction. The resulting value of ~1 keV for the well depth is much better than the previous value.

E.A.Sanderson

539.12

12940 INELASTIC SCATTERING OF COLD NEUTRONS FROM SEVERAL HYDROGENOUS LIQUIDS.

R.M.Brugger, L.W.McClellan, G.B.Streetman and J.E.Evans.

Nuclear Sci. Engng, Vol. 5, No. 2, 99-104 (Feb., 1960).

A new spinning sample method has been used to measure the energies of beryllium-filtered neutrons scattered at 90° to the beam by samples of water, ethyl alcohol, n-amyl alcohol benzene, paraffin, and zirconium hydride. The energy distributions from all samples show that an appreciable number of scattered neutrons gain energy. The zirconium hydride and water were measured to compare the spinning sample method with other methods of measuring inelastic scattering. The hydrogenous liquids were investigated to see if the scattering data could be correlated with known molecular properties and with proposed scattering theories.

539.12 : 532.7

12941 SCATTERING OF SLOW NEUTRONS BY WATER.

M.Nelkin.

Phys. Rev., Vol. 119, No. 2, 741-6 (July 15, 1960).

The motions of hydrogen atoms in water are considered in terms of the H_2O molecule as the basic dynamical unit. Vibrations, hindered rotations, and translations of the molecule are included. For the numerical calculation, the hindrance of the translations in neglected, and the hindered rotations are replaced by a torsional oscillation with a single energy, $h\nu = 0.06$ eV. When certain approximations are made in the average over molecular orientation, this model allows for the computation of differential and total slow-neutron cross-sections. The computed cross-sections are in good agreement with most of the available slow-neutron scattering data. The features of the high-resolution experiments directly associated with the hindrance of the molecular translations in the liquid are not reproduced

539.12

12942 THE ELASTIC SCATTERING OF NEUTRONS BY DEUTERONS WITH ALLOWANCE FOR POLARIZATION.

P.G.Burke and F.A.Haas.

Proc. Roy. Soc. A, Vol. 252, 177-86 (Sept. 8, 1959).

Previous calculations of the elastic scattering of low energy (< 10 MeV) neutrons by deuterons have shown a discrepancy between the calculated and observed doublet scattering lengths. It has been suggested that this may be partly due to the neglect of polarization of the deuterons and the present paper attempts to make an allowance for this effect. The problem is formulated in a variational manner and a trial function is adopted which includes an explicit polarization parameter. The internucleonic interaction is assumed to be central with Gauss radial dependence and the unperturbed deuteron ground state wave-function is represented by two Gauss terms. Using the Kohn method and taking an M.H.W.B. type exchange force, S phases were evaluated on the Deuce computer and compared with the non-polarization results of Burke and Robertson (Abstr. 686 of 1958). Polarization effects in this approximation are found to be negligible.

539.12

12943 MULTIPLE SCATTERING OF NEUTRONS.

G.W.Stuart.

Nuclear Sci. Engng, Vol. 2, No. 5, 617-25 (Sept., 1957).

A variational principle is derived for the probability that a neutron, incident upon a body of arbitrary shape and suffering multiple collisions within the body, will be absorbed by the body. Using constant trial function, the variational results are compared to sensibly exact numerical results for the case of an infinite cylinder.

539.12

12944 FAST NEUTRON SCATTERING FROM THICK SLABS.

T.D.Strickler, H.E.Gilbert and J.A.Auxier.

Nuclear Sci. Engng, Vol. 3, No. 1, 11-18 (Jan., 1958).

An experimental evaluation has been made of the Po—Be fast neutron absorbed dose albedos for concrete, water and aluminium. By assuming neutrons are scattered isotropically in the centre of mass system, a good fit to Plesset's albedo theory was obtained. The values for the albedos were found to be 0.32 for aluminium and concrete, and 0.092 for water.

539.12

12945 YVON'S METHOD FOR SLABS.

S.Ziering and D.Schiff.

Nuclear Sci. Engng, Vol. 3, No. 6, 635-47 (June, 1958).

The method of half-range polynomials is applied to neutron transport theory. The specific applicability of this method to problems having discontinuities in the nuclear parameters at the boundaries or interfaces is discussed. Half-range polynomial expansions are used to obtain solutions for both finite and semi-infinite slabs, which consist of isotropically scattering media. The results indicate that the half-range approximations compare favourably with higher approximations obtained from the full-range spherical harmonic or several discrete ordinate methods. In particular, the poor convergence, found in the full-range methods in regions close to the discontinuity, is not present in the half-range method. The latter method is used to obtain a pair of second-order coupled differential equations, as in diffusion theory.

539.12

12946 SOME CHARACTERISTICS OF THE THERMAL NEUTRON SCATTERING PROBABILITY.

R.K.Osborn.

Nuclear Sci. Engng, Vol. 3, No. 1, 29-37 (Jan., 1958).

An explicit form for the function representing the probability that a neutron with velocity v' shall be scattered into an element of volume in velocity space d^3v about v, by elastic collisions with atoms of arbitrary mass number A in a Maxwell—Boltzmann distribution characterized by a temperature T, is derived. Analytical representations of this probability are presented for scattering cross-section which are either independent of relative speed or exhibit a Gaussian dependence. The scattering probability resulting from the former assumption is examined in some detail, and then employed in a calculation of the mean energy change per collision.

539.12

12947 ON THE MULTIPLE SCATTERING OF NEUTRONS IN HYDROGEN-LIKE SUBSTANCES. C.H.Blanchard.

clear Sci. Engng, Vol. 3, No. 2, 161-70 (Feb., 1958).

The spatial moments $\overline{r^2}$, $\overline{r^4}$, and $\overline{r^6}$ are calculated exactly for all rgies below the source energy, for a point, isotropic source in an nite, homogeneous medium in which there is no absorption and in ch the scatterers scatter like hydrogen but with a 1/v cross-section. a monoenergetic source these moments are approximately con- tent with a diffusion (Yukawa) radial distribution of the very low rgy neutrons. Integration over a fission-like source spectrum, exp $(-\alpha E)$, gives moments consistent with a radial distribution he very low energy neutrons of the form of a first collision den- , $r^{-2} \exp(-r/\lambda)$, but with a mean free path λ approximately twice mean free path at the average source energy. The results are npared with those given by the first collision approximation.

539.12

12948 TEMPERATURE DEPENDENCE OF THE THERMAL DIFFUSION LENGTH IN WATER. R.W.Deutsch.

clear Sci. Engng, Vol. 1, No. 3, 252 (July, 1956).

539.12

12949 THE THERMAL NEUTRON FLUX IN A SQUARE LATTICE CELL. E.R.Cohen.

clear Sci. Engng, Vol. 1, No. 4, 268-79 (Aug., 1956).

The neutron distribution in the moderator of an infinite square- tice array is found assuming diffusion theory and a uniform oduction of neutrons throughout the moderator. Variation of utron flux density along the sides of a lattice cell is shown to be gnificant. Nevertheless, the thermal utilization of the lattice can quite accurately calculated by the use of a "cylindricalized" cell.

539.12

12950 EVALUATION OF ln E_1/E_2 FOR RESONANCE NEUTRONS IN URANIUM LATTICES. F.L.Fillmore.

clear Sci. Engng, Vol. 1, No. 5, 355-8 (Oct., 1956).

The calculation of the resonance escape probability in a lattice means of a diffusion theory model requires a knowledge of the garithmic energy width, ln E_1/E_2, of the resonance absorption gion. This quantity is evaluated by fitting the results of a diffusion eory analysis which is averaged over neutron energy to an experi- ental value of the effective resonance integral. The result is $E_1/E_2 \cong 2.6$, which is much less than the value 5.6 which is ordin- ily used in these calculations.

539.12

12951 MEASUREMENTS WITH A PULSED NEUTRON SOURCE. K.H.Beckurts.

clear Sci. Engng, Vol. 2, No. 4, 516-22 (July, 1957).

The pulse method has been applied to problems of neutron fusion in graphite. By measuring the decay constant of the utron flux emanating from various graphite pile geometries, the fusion coefficient and the absorption cross-section can be deter- ned with great precision. In comparison to an exponential experi- ent, the quantity of graphite necessary for an accurate determina- n of the diffusion length can be considerably reduced. The finite ometry of the moderator gives rise to a diffusion-cooling effect the neutron equilibrium temperature which can be understood antitatively by a direct measurement of the heat transfer from e neutron gas to the lattice. In the second part of the work, the lse method is used to determine the influence of eccentric control ds on the buckling of a cylindrical reactor model.

539.12

12952 TEN-GROUP CALCULATED EQUILIBRIUM NEUTRON SPECTRUM AND DIFFUSION LENGTH IN NATURAL RANIUM. D.Meneghetti, H.H.Hummel and W.B.Loewenstein.

clear Sci. Engng, Vol. 3, No. 2, 151-60 (Feb., 1958).

The degradation of neutron energies in a fast reactor is largely e to inelastic scattering. In a dilute fast system (large U^{238} to ^{35} atomic ratio) the neutron spectrum is then primarily deter- ined by a fission spectrum distribution modified by inelastic attering in U^{238}. In this investigation a set of ten-group fast oss-sections for U^{238} have been prepared with the inelastic cross- ctions below about 1.35 MeV based upon levels at 45, 150 and 0 keV. The inelastic transfer contributions from unknown higher vels were chosen to be consistent with the gross measurements Bethe, Beyster, and Carter, having the three-group energy vision consisting of above 1.4 MeV, between 0.4 and 1.4 MeV, and low 0.4 MeV. The ten-group fast cross-sections were tested by comparing the calculated equilibrium spectrum, diffusion length, and detector responses in natural uranium with reported experimental values found in the blanket of the Zephyr reactor and in the Snell experiments.

539.12

12953 THIN REGIONS IN DIFFUSION THEORY CALCULATIONS. E.L.Wachspress.

Nuclear Sci. Engng, Vol. 3, No. 2, 186-200 (Feb., 1958).

A method for determining effective cross-sections for geometrically thin absorbing regions in multigroup calculations is described. The effective absorption cross-section in multi-group calculations provides a smooth transition from the usual diffusion theory cross-section for low absorption slabs to the $\frac{2}{3}\lambda_{tr}$ extrapolated end-point condition for black slabs. In effect, the average flux between mesh points of the difference equation grid is related to the fluxes at the mesh points. Self-shielding effects are accounted for by material cross-section rather than difference equation modification. Application of the theory to lattice calculations is discussed, and comparisons are made with other methods for limiting cases.

539.12

12954 TWO-GROUP DIFFUSION THEORY FOR A RING OF CYLINDRICAL RODS. R.Avery.

Nuclear Sci. Engng, Vol. 3, No. 5, 504-13 (May, 1958).

The conditions for criticality and resulting flux distribution are obtained in the two-group diffusion theory approximation for a ring of N equally spaced identical cylindrical rods embedded symmetrically in a radially bare cylinder. The system is uniform axially and of either finite or infinite height. Either or both of the two media of the system may be multiplying. The method used is a generalization of the Nordheim—Scalettar method for the solution of the control rod problem of similar geometry. In satisfying each of the various boundary conditions, use is made of the Bessel function addition theorems to centre all terms in the general solution at the appropriate line of symmetry. The results are obtained in terms of a Fourier expansion of the angular dependence of the flux about each rod, which in application must be cut off after some early term in the infinite series. The order of the critical determinant is equal to twice the number of angular terms retained.

539.12

12955 EQUIVALENCE FACTORS FOR D_2O. C.Kelber.

Nuclear Sci. Engng, Vol. 3, No. 5, 633-4 (May, 1958).

Equivalence factors with respect to D_2O for Mg, Al, Zr, and stainless steel are given for two groups. Group I covers neutron energies from 10 MeV to 180 keV, Group II from 180 keV to 1.4 eV. The D_2O constants for these groups and the equivalence factors are given in tables.

539.12

12956 SOLUTION OF THE TIME-DEPENDENT THERMAL NEUTRON DIFFUSION EQUATION. LaM.I.Deverall.

Nuclear Sci. Engng, Vol. 4, No. 3, 495-8 (Sept., 1958).

The Laplace transform method is used, and is advantageous in that this method of solution does not assume that the spatial distribution of neutrons for a reactor is described by the fundamental eigenfunction, and that it may be used to study time-dependent reactor problems, such as arise in startup and situations in which the reactor is pulsed by an extraneous source of neutrons.

539.12

12957 THE METHOD OF DISCRETE ORDINATES. G.Goertzel.

Nuclear Sci. Engng, Vol. 4, No. 4, 581-7 (Oct., 1958).

The solution of the neutron transport (Boltzmann) equation in plane and spherical geometries is considered. It is demonstrated that the method of discrete ordinates differs from the spherical harmonic method merely by a linear transformation (with constant coefficients) of the dependent variables.

539.12

12958 VARIATION OF GRAPHITE DIFFUSION LENGTH WITH TEMPERATURE.

R.C.Lloyd, E.D.Clayton and C.R.Richey.

Nuclear Sci. Engng, Vol. 4, No. 5, 690-7 (Nov., 1958).

The graphite diffusion length was measured as a function of temperature in a 101 in. cube of graphite. A water-cooled BF_3 counter was used as the neutron flux detector, with additional measurements being made with gold and indium foils. The steady state neutron flux was furnished by means of four ½ gram, Ra—Be neutron sources. Measurements were taken over a range of temperature from 22° to 600° C at intervals of about 50° C. The variation of diffusion length with temperature change is in good agreement with the calculated variation assuming a 1/v cross-section for graphite and a constant transport mean free path.

539.12

12959 COMPARISON THEOREMS FOR THE ESTIMATION OF AVERAGE COLLISION PROBABILITIES. L.Dresner.

Nuclear Sci. Engng, Vol. 6, No. 1, 63-5 (July, 1959).

Three theorems are given which permit the estimation of average collision probabilities for convex solids of irregular shape by comparison with solids for which the average collision probability is known.

539.12

12960 SOLUTIONS OF THE CONSTANT VELOCITY TRANSPORT PROBLEM.

L.A.Beach, P.Shapiro, R.C.O'Rourke, W.R.Faust and B.Lepson.
Nuclear Sci. Engng, Vol. 6, No. 1, 66-75 (July, 1959).

By Fourier transform techniques the exact solutions of the one-velocity neutron diffusion problem for a uniform infinite medium with isotropic scattering have been derived for plane isotropic, plane parallel monodirectional, and plane parallel bidirectional source terms. These exact solutions in terms of Fourier inversion integrals were numerically evaluated upon the NAREC to give the angular distribution of the scattered intensity, the total scattered intensity, and the total intensity. By solving the integrals by contour integration in the complex plane, asymptotic solutions were obtained which are good approximate solutions for deep penetrations and problems with little absorption.

539.12

12961 ALBEDO OF NON-STATIONARY NEUTRON CURRENTS. M.Ribarič and J.Strnad.

"J. Stefan" Inst. Rep., Vol. 3, 31-8 (Oct., 1956).

The paper treats the changes of the albedo of time dependent neutron currents. Supposing that the elementary diffusion theory is valid, the calculations are made for a spherical, a plane, and a cylindrical boundary of an infinite reflector. Further some practical estimates and the cases in which the dynamic albedo can be approximated by the stationary one are mentioned.

539.12

12962 ALBEDO OF NON-STATIONARY TWO-GROUP NEUTRON CURRENTS. M.Ribarič and J.Strnad.

"J. Stefan" Inst. Rep., Vol. 4, 3-14 (Oct., 1957).

The paper deals with the albedo of an infinite spherical reflector for two-group time dependent neutron currents. Four particular time dependences, i.e. pulse, step, slow change and oscillation of the inward current, are discussed in detail.

539.12

12963 THE TIME DEPENDENT TWO-GROUP NEUTRON FLUX IN A HOMOGENEOUS REFLECTOR.

M.Ribarič, J.Strnad and A.Peterlin.
"J. Stefan" Inst. Rep., Vol. 4, 15-28 (Oct., 1957).

The paper deals with the two-group neutron flux in a spherical shell reflector at the one boundary of which the neutron flux is time dependent. A more detailed account is given of the phenomena due to the pulse, step change, oscillation and slow change of time dependent two-group boundary neutron fluxes.

539.12

12964 ALBEDO AND TRANSPARENCY OF REFLECTORS IN ONE-DIMENSIONAL TWO-GROUP DIFFUSION THEORY.

A.Peterlin, M.Ribarič and J.Strnad.
"J. Stefan" Inst. Rep., Vol. 4, 29-42 (Oct., 1957).

The paper deals with the two-group calculation of the neutron flux and current at the boundaries of multi-layer reflectors, and with the calculation of the critical equation by means of the albedos and transparencies of single layers. Formulae are given for the calculation of the albedos and transparencies matrix elements for spherical and cylindrical shell reflectors.

539.12

12965 ALBEDO OF NON-HOMOGENEOUS ONE-GROUP NEUTRON CURRENTS.

A.Peterlin, M.Ribarič and F.Herman.
"J. Stefan" Inst. Rep., Vol. 4, 43-55 (Oct., 1957).

The one-group diffusion theory is employed in the study of the albedo operator of slabs and cylindrical shells of non-multiplying materials for non-homogeneous neutron currents.

539.12

12966 LIMITATIONS OF MULTIGROUP CALCULATIONS. C.Klahr.

Nuclear Sci. Engng, Vol. 1, No. 4, 253-67 (Aug., 1956).

Multigroup calculations of neutron flux and current in the reflector of a thermal reactor may be seriously in error at intermediate neutron energies. This is a consequence of the assumed linear flux variation with lethargy within each group that is implicit in the multigroup method. As a result, most multigroup treatments show marked deviations from age theory at distances of several slowing down lengths (or more) from the source region. Calculations have been made to show the variation of the error in a particular multigroup treatment as a function of distance from the source (measured in slowing down lengths) and of the number of groups.

539.12

12967 TRANSPARENCY OF A PLANE SLAB OF NON-MULTIPLYING MATERIAL FOR TIME DEPENDENT NON-HOMOGENEOUS CURRENTS. M.Ribarič and F.Herman.

"J. Stefan" Inst. Rep., Vol. 4, 57-65 (Oct., 1957).

The paper contains a brief account of the transparency of a plane slab of non-multiplying material for non-homogeneous time dependent neutron fluxes.

539.12

12968 NEUTRON THERMALIZATION. I. HEAVY GASEOUS MODERATOR.

H.Hurwitz, Jr, M.S.Nelkin and G.J.Habetler.
Nuclear Sci. Engng, Vol. 1, No. 4, 280-312 (Aug., 1956).

The approximation of a heavy gaseous moderator is used as an illustrative example for the discussion of calculational methods in the thermal and epithermal energy regions. The energy distribution and migration area of neutrons in a infinite homogeneous medium are calculated numerically for 1/v absorption. Semianalytic expressions are obtained for the case of weak absorption. Finally, an expression for the slowing-down density is given and its significance for the modification of age-diffusion theory to include the thermal motion of the moderator is discussed.

539.12

12969 NEUTRON THERMALIZATION. II. HEAVY CRYSTALLINE MODERATOR. M.Nelkin.

Nuclear Sci. Engng, Vol. 2, No. 2, 199-212 (April, 1957).

The energy distribution of neutrons thermalized in an infinite homogeneous medium containing a crystalline moderator and absorbing material is investigated with the aid of a simplified model of the crystal. A Debye phonon spectrum is assumed, and a formal expansion in powers of the ratio of neutron mass to moderator atom mass is used. The inelastic scattering is approximated by the term of first order in the mass ratio, and interference effects are neglected. The resulting energy-change kernel is not correct in detail at high energies, but it correctly gives the average logarithmic energy loss, and therefore can be used in the age theory approximation at energies well above thermal. Solutions of the integral equation for the energy spectrum have been obtained on the IBM 650 for (1/v) absorption. These are compared to solutions of the differential equation for a heavy gaseous moderator. It is found that the thermal spectra are very insensitive to the choice of scattering model, even when large departures from thermal equilibrium occur.

539.12

12970 THE CALCULATION OF MAXWELLIAN-AVERAGED CROSS SECTIONS FOR RESONANCE ABSORBERS.

J.H.Smith.
Nuclear Sci. Engng, Vol. 1, No. 5, 370-3 (Oct., 1956).

The average cross-section for a resonance absorber in a Maxwellian neutron spectrum is expressed by formulae which permit accurate and simple evaluation for a wide range of nuclear parameters.

539.12

12971 NEUTRON TEMPERATURE MEASUREMENTS IN GRAPHITE. M.Küchle.

Nuclear Sci. Engng, Vol. 2, No. 1, 87-95 (Feb., 1957).

In various graphite piles, where one or two Ra—Be sources were producing a stationary neutron field, the neutron temperature was measured by activating an indium foil, sandwiched between two old absorbers. The neutron temperature was found to be up to 0° C above the graphite temperature, which is explained by the in- omplete thermal equilibrium.

539.12

12972 ATTENUATION OF 14.1 MeV NEUTRONS IN WATER.
R.S.Caswell, R.F.Gabbard, D.W.Padgett and W.P.Doering.
uclear Sci. Engng, Vol. 2, No. 2, 143-59 (April, 1957).

The attenuation of 14.1 MeV neutrons in water has been studied nder conditions simulating an isotropic point source of mono- nergetic neutrons in an infinite water medium. The migration rea of thermal neutrons $(\langle r^2 \rangle th/6)$ was found to be 156 ± 6 cm^2. ast neutron dose measurements are in agreement with the theoreti- al calculations of Goldstein et al.

539.12

12973 THE MODAL NON-ESCAPE PROBABILITY OF NEUTRONS FOR CONVEX BODIES. G.W.Antony.
uclear Sci. Engng, Vol. 2, No. 2, 220-4 (April, 1957).

539.12

12974 THE NEUTRON VELOCITY SPECTRUM IN A HEAVY MODERATOR. E.R.Cohen.
uclear Sci. Engng, Vol. 2, No. 3, 227-45 (May, 1957).

The differential equation developed by Wilkins to represent the elocity spectrum of neutrons in a heavy moderator is investigated or the case of 1/v absorption. An exact solution to terms of second rder in the absorption parameter allows an accurate determination f the asymptotic neutron density. For large absorption parameters numerical integration can yield higher accuracy. The analytic olution is applied to the calculation of the total migration area of eutrons from a monoenergetic source.

539.12 : 539.17

SPECTRA OF SECONDARY NEUTRONS PRODUCED IN THE ASSAGE OF FAST NEUTRONS. See Abstr. 11442

539.12

12975 THE WIGNER—WILKINS CALCULATED THERMAL NEUTRON SPECTRA COMPARED WITH MEASURE- MENTS IN A WATER MODERATOR. H.J.Amster.
uclear Sci. Engng, Vol. 2, No. 3, 394-404 (May, 1957).

The calculational advantages of the Wigner—Wilkins thermal lux spectra make it a desirable theory to use for the determination f thermal group constants in water-moderated reactor systems; owever, the physical assumptions required by the theory are far rom satisfied by water, and an experimental verification of the heory is called for. Such data have been furnished by Poole at Harwell. Comparisons with calculations from the theory of Wigner and Wilkins show surprisingly good agreement, although some onsistent deviations are noted.

539.12

12976 MONTE CARLO CALCULATION OF THE SLOWING- DOWN TIME DISTRIBUTION FOR NEUTRONS IN HYDROGEN. G.E.Haynam and M.F.Crouch.
uclear Sci. Engng, Vol. 2, No. 5, 626-30 (Sept., 1957).

The time required to slow neutrons down to various energies n a hydrogenous moderator is calculated by the Monte Carlo method. Exponential distributions are used for logarithmic energy oss and for distribution of free paths, and empirical cross section ata are used to calculate the mean transit time between collisions t each energy. Results are presented in tabular form, and it is urther shown that the distribution of slowing-down times at pithermal energies is well represented by a Pearson type III curve.

539.12

12977 EXPERIMENTAL MEASUREMENT OF THE SLOWING- DOWN TIME DISTRIBUTION FOR NEUTRONS IN WATER. M.F.Crouch.
uclear Sci. Engng, Vol. 2, No. 5, 631-9 (Sept., 1957).

Fast neutrons are produced inside a water moderator by a Po—α—Be source used effectively as a pulsed neutron source. The lowing-down time to the Cd edge is measured with a BF$_3$ proportion- l counter used with a cadmium difference technique. The mean lowing-down time to 0.35 eV, and the variance thereof, are found to e 5.2 μsec and 8.0 μsec^2, respectively. It is shown that this is in easonable agreement with the results of a Monte Carlo calculation, rovided collisions are considered to involve whole H$_2$O molecules when the neutron energy falls below about 1.6 eV.

539.12

12978 CALCULATION OF THERMAL GROUP CONSTANTS FOR MIXTURES CONTAINING HYDROGEN.
C.D.Petrie, M.L.Storm and P.F.Zweifel.
Nuclear Sci. Engng, Vol. 2, No. 6, 728-44 (Nov., 1957).

The calculation of averaged thermal diffusion coefficients and absorption cross sections for hydrogenous assemblies is discussed, and numerical results are presented. Comparison is made with available experimental information. The averages are taken over Wigner—Wilkins spectra, which assume moderation by a perfect gas of hydrogen atoms in the presence of a 1/v absorber. The Radkowsky prescription has been used to obtain transport cross-sections for various compounds containing hydrogen. Power series expansions are presented which simplify the calculation of average diffusion coefficients for mixtures.

539.12

12979 NEUTRON AGE IN DIPHENYL.
N.C.Francis, M.L.Storm and P.F.Zweifel.
Nuclear Sci. Engng, Vol. 2, No. 6, 745-7 (Nov., 1957).

539.12

12980 THE THERMAL NEUTRON SPECTRUM IN A DIFFUSING MEDIUM. H.Hurwitz, Jr and M.S.Nelkin.
Nuclear Sci. Engng, Vol. 3, No. 1, 1-10 (Jan., 1958).

The energy-dependent thermal diffusion equation is considered in a region free of external sources. Two cases of experimental interest are calculated. The first of these is the steady-state condition where an eigenvalue problem for the thermal diffusion length is obtained. The associated eigenfunction is the neutron spectrum. The second case, which is mathematically identical to the first, is the exponential decay in time of the thermal flux in a pulsed source experiment. The neutron leakage is assumed to be describable by a single eigenvalue for the buckling. In this case the eigenvalue is the decay constant of the flux. When the ratio of absorption cross-section to transport mean free path decreases with energy in the thermal region, the first case will give a "diffusion hardening" and the second case " a diffusion cooling" of the neutron spectrum compared to a Maxwellian distribution at the moderator temperature. These effects are investigated quantitatively for the model of a heavy gaseous moderator.

539.12

12981 CALCULATIONS OF NEUTRON DISTRIBUTIONS BY THE METHODS OF STOCHASTIC PROCESSES.
C.N.Klahr.
Nuclear Sci. Engng, Vol. 3, No. 3, 269-85 (March, 1958).

A new method of calculating steady-state neutron distributions in moderator materials is developed using the method of stochastic processes. In this method neutron life histories are considered as stationary Markoffian time series. The probability distribution for the neutron to be in a particular point in phase space as a function of time from neutron birth is then found by solving an appropriate Fokker—Planck equation whose coefficients depend on the one-collision probability distributions. This method has important applications to calculations of flux spectra and to shielding problems involving deep neutron penetration. When simplifying approximations are made, solutions for the flux have the correct qualitative features of the Boltzmann equation solutions. Quite good quantitative agreement is obtained with the Bethe—Tonks—Hurwitz solution of the Boltzmann equation. Effects of absorption, anisotropic scattering, and a mixture of materials can also be included. By the present method the neutron flux distribution can be calculated in position, lethargy, velocity angle, and possibly other variables, for a homogeneous infinite moderating medium at both large and small distances from the source. The neutron flux spectrum from an infinite plane source in an infinite medium has been calculated, as well as the angular distribution of the neutrons. Constant cross-sections and high atomic weight are assumed but it is pointed out that these restrictions can both be relaxed.

539.12

12982 THE AGE OF POLONIUM—BORON NEUTRONS IN WATER. M.Reier.
Nuclear Sci. Engng, Vol. 3, No. 3, 374-5 (March, 1958).

539.12

12983 THE AGE OF POLONIUM—BERYLLIUM NEUTRONS IN VARIOUS METAL-WATER MIXTURES.
M.Reier, F.Obenshain and R.L.Hellens.
Nuclear Sci. Engng, Vol. 4, No. 1, 1-11 (July, 1958).

The slowing-down distribution of Po—Be neutrons has been measured in aluminium—water, zirconium—water, and iron—water mixtures up to metal water ratios of 2 : 1 by volume. The second moment of the distribution has been obtained from these measurements and compared with theoretical calculations based on a solution of the transport equation. The effect of varying the source spectrum and cross-sections in the calculations is discussed.

539.12

12984 NEUTRON AGE IN MIXTURES OF D_2O AND H_2O.
J.W.Wade.

Nuclear Sci. Engng, Vol. 4, No. 1, 12-24 (July, 1958).

The neutron age for fission neutrons and Po—Be neutrons was measured in mixtures of D_2O and H_2O. The age was evaluated from the second moment of the slowing-down distribution at the 1.4 eV resonance of indium. The ages of fission neutrons at concentrations of 99.8, 99.0, 98.4, 95.3, 94.0, 91.8, 48.6% D_2O, and in pure H_2O were 109, 107, 106, 93, 86, 78, 38.6 and 31 cm^2, respectively. In the range from 100 to 90% D_2O, the rate of decrease of the age was approximately 4 cm^2 for each additional per cent of H_2O. The ages of Po—Be neutrons in 99.4, 48.6% D_2O, and in H_2O were 148, 72.5, and 55.7 cm^2, respectively.

539.12

12985 APPLICATION OF THE ABSORPTION AREA METHOD TO THREE-GROUP DIFFUSION THEORY PROBLEMS.
S.Pearlstein.

Nuclear Sci. Engng, Vol. 4, No. 3, 322-31 (Sept., 1958).

The absorption area method allows rod absorptions to be considered without treating the rods as discrete boundaries. The source neutrons for a rod absorbing neutron energy group are reduced in proportion to the rod absorption area. This paper presents rod absorption factors based on absorption area calculations that may be applied in any reactor region penetrated by the rods. The factors derived are dependent on the core and rod composition, rod geometry, and include rod interaction effects.

539.12

12986 AGE TO INDIUM RESONANCE FOR D-D NEUTRONS IN WATER.
V.Spiegel, Jr, D.W.Oliver and R.S.Caswell.

Nuclear Sci. Engng, Vol. 4, No. 4, 546-62 (Oct., 1958).

The average 1.44 eV indium resonance age has been determined from activation measurements for a $D(d,n)He^3$ neutron source in water. The energy of the incident deuteron beam was 250 keV. The source emits neutrons anisotropically with energies from 3.12 MeV at 0° to 2.00 MeV at 180°. The activities were averaged over angle by the Gauss integration procedure using angles of 20.3°, 90°, and 159.7°. The average age, when corrected for the absence of moderator in the duct which brings the deuteron beam into the medium, is 34.6 ± 2.2 cm^2. Rigorous theoretical calculations for a D + D neutron source by Zweifel give 33.6 cm^2 for 100 keV incident deuterons and 33.8 cm^2 for 150 keV deuterons. Any estimate of an age for a 250 keV D^+ source would yield a larger value of age and closer agreement with this experiment. The variation of measured ages versus angle may be understood qualitatively on the basis of effects due to the duct and the anisotropy of the source. A more precise theoretical check of this experiment is expected from Monte Carlo calculations for precisely this geometry and source.

539.12

12987 A REMARK ON NEUTRON THERMALIZATION THEORY.
G.Leibfried.

Nuclear. Sci. Engng, Vol. 4, No. 4, 570-5 (Oct., 1958).

The slowing down of neutrons by a monoatomic moderator gas with temperature can be expressed by a variational formalism. Using a suitable trial solution one can calculate the effective neutron temperature and the upper limit of the thermal region by variation. Results are given for large moderator masses and small absorption.

539.12

12988 TWO GROUP CALCULATION OF PROMPT NEUTRON LIFETIME.
W.H.Arnold, Jr.

Nuclear Sci. Engng, Vol. 4, No. 4, 598-600 (Oct., 1958).

A simple formula for the calculation of l^*, the prompt neutron lifetime, is derived from two group reactor theory. It is pointed out that the group neutron velocity (v) which appears in the equations should be calculated by inverting the average of 1/v.

539.12

12989 RESONANCE ESCAPE PROBABILITY IN HYDROGENOUS LATTICES.
W.W.Clendenin.

Nuclear Sci. Engng, Vol. 5, No. 1, 1-4 (Jan., 1959).

A series expansion method is used to obtain approximate solutions of the velocity-dependent transport equation near a resonant energy. Numerical examples of typical cases are given.

539.12

12990 A SIMPLE ANALYTICAL FORMULATION OF THE DANCOFF CORRECTION.
J.A.Thie.

Nuclear Sci. Engng, Vol. 5, No. 2, 75-7 (Feb., 1959).

The Dancoff correction to the surface term of a resonance integral has hitherto required tedious numerical evaluation of a double integral in cylindrical geometry. A recognition of the functional dependence of the correction on moderator mean free path λ allows a great simplification. If 1-C is the surface correction for two rods c radius, ρ, separated a distance d between centres, then:

$$C = (4/\pi^2)Ki_3[(|\Delta\rho|/\rho)(\rho/d)]\arcsin(\rho/d)$$

where $|\Delta\rho|/\rho$ is a function monotonically increasing with d/ρ, for which a graph is given. A simple formula is also given for C of a hollow rod's interior.

539.12

12991 NEUTRON THERMALIZATION CALCULATIONS FOR A HETEROGENEOUS LATTICE CONTAINING URANIUM AND PLUTONIUM FUEL IN WATER.
P.Greebler, W.Harker and J.Harriman.

Nuclear Sci. Engng, Vol. 6, No. 2, 128-34 (Aug., 1959).

In a low-enrichment reactor at sufficiently high temperature that the Pu^{239} absorption cross-section departs appreciably from 1/v, plutonium build-up increases the sensitivity of the calculated thermal cross-sections to the thermalization techniques used. Thermal neutron spectra are compared for two thermalization models in a heterogeneous lattice of a low-enrichment water-moderated reactor. Using blackness theory, equivalent homogeneous monoenergetic cross-sections for the lattice are computed at closely spaced energy intervals over the thermal energy range. The energy distribution of the thermal neutron flux is then obtained using both the Wigner—Wilkins and the Wilkins thermalization equations. Calculations are made with the fuel elements assumed to contain only U^{235} and U^{238} yielding almost pure 1/v absorption, and also for the case of appreciable Pu^{239} present in addition to the uranium resulting in a significant departure from 1/v absorption. Sensitivity of the calculated spectrum to the effective mass of the hydrogen is tested by allowing wide variations of the $\xi\sigma_s$ values for water at low energies in several applications of the Wilkins equation. Variations in the thermal neutron spectra, resulting from the choice of the thermalization equation (Wigner—Wilkins or Wilkins), from changing $\xi\sigma_s$, or as a result of plutonium build-up, are evaluated in terms of isotopic cross-sections averaged over the spectrum in each case.

539.12 : 539.17

12992 ON THE THEORY OF THE DIFFUSION COOLING OF NEUTRONS IN A FINITE SOLID MODERATOR ASSEMBLY.
K.S.Singwi.

Ark. Fys., Vol. 16, Paper 36, 385-411 (1960).

Starting from the transport equation in the diffusion approximation, the energy-dependent part of the solution is expressed in terms of generalized Laguerre polynomials of order unity and degree n, each term of which is weighted by a Maxwellian distributi function. In the approximation in which only the first two terms of the Laguerre expansion are retained, exactly the same expression is obtained for the decay constant of the fundamental mode as in the variational approach of Nelkin and of Singwi and Kothari. In the next higher approximation, a "non-Maxwellian" correction to the diffusion cooling constant of ~20-25% occurs. The theory avoids the assumption of a neutron temperature which was the weak point of the variational approach. An expression for the correction to the diffusion cooling constant arising from terms of order B^6 has also been derived of sign opposite to that of the non-Maxwellian correction and of quite significant magnitude, depending on the value of the buckling, B^2 of the assembly. Non-diffusion correction to the decay constant has also been estimated and it is found that it is negligible compared to the multi-velocity correction. Expressions for the mean energy of neutrons inside and outside the assembly are derived. Finally the variation of the diffusion cooling constant with the temperature of the moderating assembly is studied in the two limiting cases: (i) $T/\theta \rightarrow \infty$ and (ii) $\theta/T \rightarrow \infty$, θ being the Debye temperature of the solid. Exact evaluation of this variation is show graphically in the case of beryllium. Comparison of the theoretical values of the diffusion cooling constant with the experimental values for beryllium, beryllium oxide and graphite has been made. If the ansport mean free path is assumed to be independent of energy, the reement between theory and experiment is good in the case of aphite and beryllium, but not in the case of beryllium oxide for ich the experimental value seems to be rather high.

539.12

12993 SPATIAL DISTRIBUTION OF THERMAL NEUTRONS FROM AN N^{17} SOURCE IN WATER.

.Shure and P.A.Roys.
uclear Sci. Engng, Vol. 2, No. 2, 170-80 (April, 1957).

The thermal neutron flux in a water medium from a source disk ntaining water irradiated in the Materials Testing Reactor has een measured using a BF$_3$ detector. Neutrons from N^{17} and photo-eutrons from N^{16} gamma rays have been observed. The radial stribution of thermal neutrons from an isotropic point source of ^{17} neutrons in a water medium out to 35 cm has been deduced, and s been compared with a theoretical calculation of the distribution ised on Holte's values of the collision density at 1 eV from a point otropic source of 1 MeV neutrons. From the results of this xperiment and Holte's distribution, the square of the diffusion ngth plus the age from 1 eV to thermal energies, has been lculated to be 8.2 cm^2. This value is in reasonable agreement ith previously reported measured values.

539.12 : 539.1.07

MEASUREMENT OF THE FLUX OF THERMAL NEUTRONS IN A NIFORM MEDIUM BY MEANS OF NUCLEAR EMULSIONS.

e Abstr. 12794

539.12

12994 MEASURING THE RATIO OF THERMAL TO RESONANCE NEUTRON DENSITIES USING THICK INDIUM FOILS.

.A.Greenfield, R.L.Koontz and A.A.Jarrett.
uclear Sci. Engng, Vol. 2, No. 3, 246-52 (May, 1957).

Measurements have been made of the cadmium ratios of dium foils for thicknesses ranging from 0.012 mg/cm^2 to approx-nately 100 mg/cm^2. Correction factors are presented both graphi-ally and in tabular form to determine the ratio of thermal to esonance neutron densities from measurements made with an dium foil of any thickness up to 100 mg/cm^2.

539.12

12995 FOIL DEPRESSION FACTORS FOR INDIUM DISK DETECTORS. T.L.Gallagher.

uclear Sci. Engng, Vol. 3, No. 1, 110-12 (Jan., 1958).

539.12

12996 USE OF ALUMINUM AS A THRESHOLD NEUTRON DETECTOR. F.E.Jablonski and A.F.DiMeglio.

uclear Sci. Engng, Vol. 3, No. 5, 631-3 (May, 1958).

Discusses the usefulness of aluminium for determining the eutron flux above 2.1 MeV. When aluminium is exposed to reactor eutrons, the activations which occur are (a) thermal, Al^{27}(n,γ)Al^{28}, nd (b) fast, Al^{27}(n,p)Mg^{27}. The amount of thermal and fast activation nduced is determined by counting the 1.8 MeV gammas from Si^{28} nd the 0.84 MeV gammas from Al^{27}, i.e. gammas from the β-decay roducts of Al^{28} and Mg^{27}. For experiments, the counting system onsisted of a NaI well crystal, a nonoverload linear amplifier, and twenty channel analyser in which the photopeak spectra were re-orded. γ-rays from Mn^{56} were used for calibration purposes.

539.12

12997 FAST NEUTRON DOSIMETRY IN PILE IRRADIATIONS. R.W.Houston.

uclear Sci. Engng, Vol. 4, No. 2, 227-38 (Aug., 1958).

For samples exposed in high neutron flux regions of reactors e contribution to the total dosage due to the recoils from elasti-ally scattered fast neutrons may be significant. The calculation f this contribution is considered here. Three methods are pre-ented, each differing in the manner in which the details of the nergy distribution of fast neutrons are treated. In the first, the eutron flux per unit energy interval is assumed to be of the asymp-otic or 1/E form up to fission energies. In the second and third, separate computation is made for the uncollided neutrons reaching e sample. The remaining contribution due to once-scattered eutrons is treated as in the first method, but alternate forms for e source spectrum of once-scattered neutrons are considered. se of the equations requires only a knowledge of the thermal eutron flux in the vicinity of the sample. Assumptions and limi-ations are discussed. Numerical results are presented for compa-ison of the effects in light water, heavy water, and graphite mode-ated reactors in the irradiation of a hydrocarbon (cyclohexane) ample.

539.12

12998 COMPUTING ABSOLUTE THERMAL NEUTRON FLUX FROM MEASUREMENTS MADE WITH INDIUM FOILS. M.A.Greenfield, R.L.Koontz and A.A.Jarrett.

Nuclear Sci. Engng, Vol. 4, No. 4, 563-9 (Oct., 1958).

The method for computing absolute thermal neutron flux from measurements made with activated indium foils is described. By combining data from the counting rate of indium foils in 2π proportional counters with appropriate corrections for foil weights and neutron effects, the thermal flux is expressed in terms of σ_0, the thermal absorption cross-section of In^{115}. This procedure may be used by laboratories which do not have access to a standard graphite pile or to a standard neutron source. This method has an estimated error of less than 5% which is a function of the accuracy with which it is possible to determine the various correction factors for beta counting. A possible fixed error in the value of σ_0 can easily be corrected for and incorporated into the methods used.

539.12

12999 MEASUREMENT OF NEUTRON SPECTRA OF THE EXPERIMENTAL BREEDER REACTOR.

C.Eggler, C.M.Huddleston, V.E.Krohn and G.R.Ringo.
Nuclear Sci. Engng, Vol. 1, No. 5, 391-408 (Oct., 1956).

The neutron spectra at two positions in the core and two positions in the inner blanket of the Experimental Breeder Reactor in Idaho have been measured by means of beams extracted from these positions. The energy range covered was from 75 keV to 4 MeV. A cloud chamber was used for the measurement from 75 keV to 1 MeV and recoil-proton tracks in nuclear plates for that from 0.8 to 4 MeV. Reaction rate ratios measured inside the reactor agree well with those calculated from known cross sections and the spectra found in the beams.

539.12

13000 STORAGE OF COLD NEUTRONS. Ya.B.Zel'dovich.

Zh. eksper. teor. Fiz., Vol. 36. No. 6, 1952-3 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1389-90 (Dec., 1959).

A quantitative discussion is given of the feasibility of storing cold neutrons (velocity <500 cm sec^{-1}) in a cavity with graphite reflecting walls. By first cooling the neutrons in liquid helium, 10^{-5} of the neutrons are in the velocity limit as compared with 10^{-8} at room temperature. It might be possible to accumulate 5×10^7 neutrons in a 1 m^3 cavity. A.Ashmore

Mesons

539.12

13001 POSSIBLE METHOD OF SEARCH FOR THE ρ^0 MESON.

V.G.Zinov, A.D.Konin, S.M.Korenchenko and B.Pontekorvo [Pontecorvo].
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1948-50 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1386-7 (Dec., 1959).

It is proposed to examine the energy dependence of the π^--proton cross-section for elastic scattering, in order to look for the narrow singularities which could be interpreted as threshold anomalies (see following abstract), indicating the threshold for production of ρ^0 particles. The necessary energy resolution for such an experiment is discussed, together with the question of the effect of too short a lifetime for the ρ^0. R.F.Peierls

539.12

13002 SINGULARITIES OF THE S-MATRIX AND THE ρ^0 MESON.

V.I.Gol'danskii and Ya.A.Smorodinskii.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1950-1 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1387-8 (Dec., 1959).

A discussion is given of the nature of the cusps which may be expected to appear in the energy dependence of the pion—nucleon elastic scattering cross-sections near the threshold for the production of an assumed ρ^0 meson. It is shown that the expected width, if the cusp is of the "peak" type, is so narrow that it should be easily distinguishable from a resonance peak. R.F.Peierls

539.12

13003 DETERMINATION OF THE CAPTURE FREQUENCY OF SLOW MESONS BY LIGHT AND HEAVY NUCLEI IN PHOTOEMULSIONS.

D.K.Kopylova, Yu.B.Korolevich, N.I.Petukhova and M.I.Podgoretskii.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1955-6 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1391-2 (Dec., 1959).

Discrimination is based on fact that Auger electrons are almost entirely associated with heavy nuclei, and π^--stars (with particles of range $\leq 50\mu$) are produced by light nuclei. E.J.Burge

539.12

13004 AN EXPERIMENT TO INVESTIGATE THE EXISTENCE OF CHARGED PARTICLES OF MASS $\sim 550\,m_e$.

N.Durga Prasad, M.G.K.Menon and O.P.Sharma.
Nuovo Cimento, Vol. 14, No. 6, 1332-41 (Dec. 16, 1959).

Evidence suggesting the existemce of charged particles of mass $\sim 550\ m_e$ has been reported by Alikhanian, Shostakovich, Dadaian, Fedorov and Deriagin. A search has been made for these particles in a photographic emulsion stack exposed for five months at an altitude of 11 000 ft, $\lambda = 24^\circ$N at Khillanmarg (Kashmir). The central plate of the stack was scanned for all tracks, with dip angles $< 45^\circ$, due to particles brought to rest within it. A total of 5 790 tracks was obtained in this scan. Of these tracks, 2613 were due to particles, with ranges < 5 mm, emerging from nuclear disintegrations; these were not considered further. Mass measurements were carried out on the remaining 3177 tracks by the grain density versus residual range method; the range interval involved is (3-40) g/cm^3. The 3177 tracks investigated were found to be due to 1018 μ-mesons, 168 π-mesons and 1991 particles of mass $\geq 850\ m_e$. No particle with a mass estimated to be between 390 m_e and 850 m_e has been observed. Five such particles are to be expected on the abundance of $\sim\frac{1}{2}\%$ compared to μ-mesons (in the same range interval) quoted by Alkhanian et al. The question of the existence of such particles is discussed in the light of this and other experiments.

539.12

13005 SEARCH FOR THE DECAY $\mu \to e + \gamma$ AND OBSERVATION OF THE DECAY $\mu \to e + \nu + \bar{\nu} + \gamma$.

J.Ashkin, T.Fazzini, G.Fidecaro, N.H.Lipman, A.W.Merrison and H.Paul.
Nuovo Cimento, Vol. 14, No. 6, 1266-81 (Dec. 16, 1959).

Reports a search for the $\mu \to e + \gamma$ mode of decay. The result is negative within the sensitivity of the experiment: the branching ratio found was $(1.2 \pm 1.5) \times 10^{-6}$. Evidence for the existence of the decay process $\mu \to e + \nu + \bar{\nu} + \gamma$ is also presented.

539.12

13006 THE $\mu \to e + \gamma$ DECAY AND THE INTERMEDIATE CHARGED VECTOR BOSON THEORY.

P. Meyer and G.Salzman.
Nuovo Cimento, Vol. 14, No. 6, 1310-21 (Dec. 16, 1959).

The μ—e—γ vertex is calculated in the intermediate charged vector boson theory, as a function of the square of the four momentum of the photon. Consistency arguments show that the boson anomalous magnetic moment should be taken equal to zero. The result is then specialized to a real photon. The experimental branching ratio

$$\rho = (\mu \to e + \gamma)/(\mu \to e + \nu + \bar{\nu}) = (1.2 \pm 1.5) \times 10^{-6}$$

fixes the cut-off value at less than one fifth the intermediate boson mass. It is concluded that this theory does not reasonably account for the experimental data, no matter how massive the boson is assumed to be.

539.12

13007 THE "CATALYTIC" AND "PHOTO" DECAY MODES OF THE MUON. S.P.Rosen.

Nuovo Cimento, Vol. 15, No. 1, 7-17 (Jan. 1, 1960).

It is shown that, on the basis of the usual baryon—lepton direct coupling theory, the "catalytic" ($\mu + N \to e + N$) and the "photo" ($\mu \to e + \gamma$) decays of the muon are expected to occur as second order processes in the effective weak interaction Hamiltonian, H_{weak}. If however, the effective weak interaction itself arises as a consequence of the coupling of baryons and leptons to an intermediate heavy boson ("X"), these decays are essentially first order in H_{weak}, and are predicted to go so fast as to apparently contradict experimental data, at least in the case of photo decay. Estimates of the rates of the catalytic and photo decays are given both on the direct coupling and on the "X" theories and a comparison with the available empirical limits on these rates is made.

539.12

13008 ON THE ROLE OF THE INTERMEDIATE BOSON IN $\mu \to e + \gamma$ DECAY. M.E.Ebel and F.J.Ernst.

Nuovo Cimento, Vol. 15, No. 2, 173-80 (Jan. 16, 1960).

The dependence of the branching ratio

$$R(\mu \to e + \gamma)/R(\mu \to e + \nu + \bar{\nu})$$

upon the ratio of cut-off to boson mass and upon a possible boson anomalous moment is discussed. Some of the properties of the boson are inferred from the present experimental data.

539.12

13009 THREE-ELECTRON DECAY OF THE MUON. I.I.Gurevich, B.A.Nikol'skii and L.V.Surkova.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 318-19 (July, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 1, 225-6 (Jan., 1960).

An event was recorded in nuclear emulsions with three relativistic particles appearing to originate in the decay of a μ-meson from $\pi \to \mu$ decay. Possible interpretations are discussed. S.J.Goldsack

539.12 : 539.2

LEAD K ABSORPTION EDGE FOR μ-MESON MASS DETERMINATION. See Abstr. 11559

539.12

13010 POSSIBILITY OF DETERMINING THE CHIRALITY OF THE MUON BY MEANS OF δ-ELECTRON CASCADES FROM MAGNETIZED IRON. A.I.Alikhanov and V.A.Lyubimov.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1334-5 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 946-7 (Oct., 1959).

Gives a formula by Berestetskii for the scattering cross-section of a polarized muon by polarized electrons, and estimates that δ-cascades from 1.5×10^6 muons should allow a Pμ of 100% to be measured with 30% accuracy. E.J.Burge

539.12

13011 A THEOREM ON THE ELIMINATION OF CONTACT MUON—ELECTRON INTERACTIONS.

N.Cabibbo, R.Gatto and C.Zemach.
Nuovo Cimento, Vol. 16, No. 1, 168-74 (April 1, 1960).

A general theorem on the elimination of possible contact muon—electron interactions is given which includes as particular cases a theorem by Cabibbo and Gatto (Abstr. 5577 of 1960), and a theorem by Feinberg, Kabir and Weinberg (Abstr. 2561 of 1960) for particular types of interactions.

539.12

13012 THE NON-INDICATION OF THE "ANOMALOUS" SCATTERING OF μ-MESONS.

S.Fukui, T.Kitamura and Y.Watase.
Progr. theor. Phys., Vol. 19, No. 3, 348-50 (March, 1958).

A μ-meson scattering experiment, in which special care was taken in the μ-meson momentum determination, is described. The results fit the expected angular distribution for Coulomb scattering by a point charge, and show no indication of "anomalous" scattering. E.J.Squires

539.12

13013 ELECTRONS FROM μ-CAPTURE AND THE RADIUS OF FERMI INTERACTIONS. B.Jouvet and J.C.Houard.

Nuovo Cimento, Vol. 15, No. 1, 31-44 (Jan. 1, 1960).

This paper proposes to determine the range of Fermi interactions by measuring vacuum polarization effects resulting from Fermi couplings. A typical process is studied: the electron emission in muon capture, which would occur if neutrinos emitted in electron and μ-capture were identical. Lower bounds of radii parameters of Fermi interactions are obtained from the actual measured ratio $(\mu \to e)/(\mu \to \nu)$. The implication of this ratio in the single intermediate boson Fermi interaction theories is also discussed, and could be tested by the experiments of nuclei excitation by neutrinos.

539.12

13014 **ON A POSSIBLE DETERMINATION OF THE SIGN OF MUON POLARIZATION.** S.A.Kheifets.

'h. eksper. teor. Fiz., Vol. 36, No. 5, 1588 (May, 1959). In ussian. English translation in: Soviet Physics--JETP (New York), 'ol. 36(9), No. 5, 1128 (Nov., 1959).

It is shown that after about 125 revolutions in a magnetic field n initially longitudinally polarized μ-meson will become transversely olarized because of the action of the anomalous magnetic moment. t is suggested that the absolute sign of this polarization could then e determined by studying Coulomb scattering of the μ's in heavy naterials. It is suggested that such an experiment could usefully e combined with one to measure the anomalous moment precisely.

S.J.Goldsack

539.12

13015 **A UNIFIED MODEL OF K- AND π-MESONS.** T.H.R.Skyrme.

'roc. Roy. Soc. A, Vol. 252, 236-45 (Sept. 8, 1959).

On the foundation of an antecedent non-linear meson field heory (Abstr. 13003 of 1960) it is suggested that the π-meson fields nay be described in terms of collective motions of the K-meson ields. A particular model of the K—nucleon interaction is considered vhose collective π-modes have symmetrical PV coupling with the ucleon system; parity is conserved to a great extent for the —nucleon system in the absence of strange particles. The direct K—nucleon interactions do not conserve parity; their sign and ymmetry are qualitatively acceptable. The masses and coupling onstants of the meson fields are determinate in terms of one niversal coupling constant and a cut-off. The structure of this nodel suggests a natural way for the introduction of the "spurion", lescribing weak interactions that violate strangeness.

539.12

13016 **ENERGY DEPENDENCE OF THE SPATIAL ASYMMETRY OF POSITRONS IN $\pi^+ \rightarrow \mu^+ \rightarrow e^+$ DECAY.**

A.O.Vaisenberg, V.A.Smirnit-Skii, É.D.Kolganova and N.V.Rabin.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 326-8 (July, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 1, 231-2 (Jan., 1960).

$\pi \rightarrow \mu \rightarrow e$ decays in an emulsion exposed to a magnetic field of 17 000 gauss were examined for the spatial asymmetry of the positrons relative to the μ-meson direction. The energy of each positron was estimated by scattering, and the asymmetry coefficient letermined for each energy interval. It rises steeply over the spectrum in agreement with the expectation of the two-component neutron theory.

S.J.Goldsack

539.12

13017 **INTERNAL-CONVERSION PAIRS IN THE DECAY OF NEUTRAL π-MESONS.**

Yu.A.Budagov, S.Viktor, V.P.Dzhelepov, P.F.Érmolov and V.I.Moskalev.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1047-52 (April, 1960). In Russian.

Twenty-seven charge-exchange scattering events with subsequent decay $\pi^0 \rightarrow e^- + e^+ + \gamma$ were recorded in a hydrogen-filled diffusion cloud chamber located in a magnetic field and operating in 128 MeV and 162 MeV negative π-meson beams. The probability of this decay relative to the usual decay was found to be 0.0117 ± 0.0015. The results of measurement of the momenta and angles of the electron—positron pairs are presented. The experimental energy characteristics of the pairs and angular distributions are in satisfactory agreement with the theoretical ones.

539.12

13018 **ELASTIC SCATTERING OF 128 AND 162 MeV π^--MESONS BY PROTONS.** Yu.A.Budagov, S.Viktor, V.P.Dzhelepov, P.F.Ermolov and V.I.Moskalev.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 734-46 (March, 1960). In Russian.

A hydrogen-filled diffusion cloud chamber in a magnetic field was used to measure the angular distribution of 128 and 162 MeV π^--mesons elastically scattered on protons. The total elastic scattering cross-sections for these energies are, respectively, $(12.8 \pm 1.0) \times 10^{-27}$ cm^2 and $(21.4 \pm 1.2) \times 10^{-27}$ cm^2. The angular distribution has the form $a + b \cos\theta + c \cos^2\theta$. At the indicated energies the real parts of the forward scattering amplitudes (in the c.m.s.) in $\hbar/m_\pi c$ units are, respectively, 0.261 ± 0.031 and 0.216 ± 0.033. These values agree with those computed from the dispersion relations with coupling constant $f^2 = 0.08$.

539.12

13019 **THEORY OF THE LOW-ENERGY PION—PION INTERACTION.** G.F.Chew and S.Mandelstam.

Phys. Rev., Vol. 119, No. 1, 467-77 (July 1, 1960).

The double dispersion representation is applied to the problem of pion—pion scattering, and it is shown that, if inelastic effects are important only at very high energies and S-wave scattering dominates at low energy, a set of integral equations for the low-energy amplitudes can be derived. The solution of these equations depends on only one arbitrary real parameter, which may be defined as the pion—pion coupling constant. The order of magnitude of the new constant is established, and a procedure for solving the integral equations by iteration is outlined. If P-wave scattering is large the equations become singular and must be modified. Such modification can be performed, at the expense of introducing an extra parameter, but is not considered here.

539.12

13020 **S-WAVE DOMINANT SOLUTIONS OF THE PION—PION INTEGRAL EQUATIONS.**

G.F.Chew, S.Mandelstam and H.P.Noyes.

Phys. Rev., Vol. 119, No. 1, 478-81 (July 1, 1960).

The integral equations for pion—pion scattering formulated by Chew and Mandelstam (see preceding abstract) are put into a form suitable for numerical solution. An iteration procedure is described that is applicable when the S-wave amplitude dominates the equations, all higher partial waves being small; this paper considers only solutions for which such is the case. The requirement that the equations have consistent solutions without bound states turns out to limit the pion—pion coupling constant to the range $-0.46 < \lambda < \sim 0.3$. Results are given for various values of λ within this interval.

539.12

13021 **EFFECT OF PION—PION RESONANCES ON π^- p INTERACTIONS.** L.Landovitz and L.Marshall.

Phys. Rev. Letters, Vol. 4, No. 9, 474-5 (May 1, 1960).

A proposal is made to reconcile the results of two experiments which respectively give predominantly slow and predominantly fast π^- from the reaction $\pi^- + p \rightarrow \pi^- + p + \pi^0$ in the region of 1 GeV. It is pictured that the incoming pion scatters from one in the cloud, as a result of which one pion escapes and the other forms an isobar with the nucleon, which subsequently decays. Slow π^- would be given by the π—π interaction in an isotopic spin state t = 1, and fast π^- by t = 0 or 2. A rapid rise of the t = 1 state with increasing energy could possibly reconcile the results, although other difficulties would be involved.

A.Ashmore

539.12

13022 **π—NUCLEON PHASE SHIFTS IN THE ENERGY RANGE 350 TO 600 MeV.** W.D.Walker, J.Davis and W.D.Shephard.

Phys. Rev., Vol. 118, No. 6, 1612-14 (June 15, 1960).

Describes the results of attempts to obtain a set of phase shifts valid in the energy region just above the 3-3 resonance. It is possible to extend the family of phase shifts found by the workers at Dubna at an energy of about 300 MeV. The features of this set of phase shifts is that α_1, α_{11}, are positive and α_{13} is negative and small. In addition it is found that δ_{13} is positive and δ_{15} negative. At 600 MeV the results are consistent with a resonance in the $d_{3/2}$ state. At 600 MeV the results are probably consistent with a resonance in the $d_{3/2}$ state, but do not conclusively indicate such a resonance. This resonant state, however, decays a sizable fraction of the time into a final state with two π-mesons. There are indications that at energies of 400 to 500 MeV most of the single pion production comes from s and $p_{1/2}$ states.

539.12

13023 **ON PUPPI'S DETERMINATION OF THE PION—NUCLEON COUPLING CONSTANT.**

K.Matumoto, S.Otsuki, H.Shimodaira and E.Yamada.

Progr. theor. Phys., Vol. 19, No. 2, 216-17 (Feb., 1958).

It is suggested that one can obtain limits on the value of this constant, in each isobaric spin state, by fitting the one-meson exchange potential to the long-range part of the nucleon—nucleon potential, obtained by low-energy nucleon—nucleon data. The results suggest that Puppi's value of the π^-—p coupling constant is too small.

E.J.Squires

539.12

13024 **COMPOSITE MODEL OF PION AND PION-NUCLEON INTERACTION.** C.Ihara and S.Hatano.

Progr. theor. Phys., Vol. 20, No. 3, 356-68 (Sept., 1958).

Regarding the pion as the quantum of the lowest excited mode of a nucleon—antinucleon pair from a vacuum, a normalized wavefunction for the pion is obtained and used as an auxiliary variable for the treatment of the many-body problem. A canonical transformation is performed and an effective pion—nucleon interaction obtained. The result is equivalent to the customary meson theory.

539.12

13025 π—N INTERACTIONS IN GeV REGION.

Y.Kakudo, T.Goto and R.Nakasima.

Progr. theor. Phys., Vol. 19, No. 4, 353-8 (April, 1958).

π—N interactions in an energy region near 1.0 GeV are studied by means of the simple ray optical model. The energy dependences of the optical parameters, the absorption coefficient K and the index of refraction k_1, are determined so as to reproduce the behaviours of the real and imaginary parts of the forward scattering amplitude, which are calculated from the observed total cross-sections σ_T by use of dispersion relations. For convenience, the target radius of the nucleon is taken as 1.3, 1.5, or 1.6×10^{-13} cm and is assumed to have no energy dependence. The energy dependence of K is similar to that of σ_T, but k_1 displays a very different dependence, which is characterized by the fact that k_1 takes a negative value in an energy region below the energy corresponding to the maximum σ_T. Using the values of K and k_1 determined, the elastic, inelastic, and exchange scattering cross-sections for π—N collisions are calculated. According to this analysis, the choice of the nucleon radius as 1.6×10^{-13} cm seems to be consistent with experimental data. The bump which appears in the backward hemisphere of the angular distribution for the elastically scattered pions at 1.0 GeV is explained by contributions from the spin flipped scattering in D waves.

539.12

13026 FOLDY TRANSFORMATION IN THE PION—HYPERON SYSTEM. A.Kanazawa.

Phys. Rev., Vol. 118, No. 6, 1164-6 (June 15, 1960).

A unitary transformation, which plays the same role as the Foldy transformation in the pion—nucleon system, is constructed for the case where the pion interacts with both Σ and Λ hyperons through γ_5 couplings. The transformation function and the transformed Hamiltonian are very similar to those of the Foldy transformation, in spite of the complexity of the system in isotopic spin space. No applications to practical problems are considered.

539.12

13027 POLARIZATION IN PION—NUCLEON SCATTERING AND THE SECOND AND THIRD PION—NUCLEON RESONANCES. M.J.Moravcsik.

Phys. Rev., Vol. 118, No. 6, 1615-18 (June 15, 1960).

The polarization of the recoil nucleon in pion—nucleon scattering is studied from the point of view of providing a means of distinguishing among the various angular momentum assignments proposed for the higher pion—nucleon resonances. It is shown that polarization in this reaction is just as useful a guide as polarization in photoproduction. In particular, a measurement of the polarization at and in the neighbourhood of 90° in the energy range between the first and third resonances should give a fairly convincing verification of one or the other of the prevailing assignments.

539.12

13028 PION—PION SCATTERING IN THE φ^4 THEORY.

M.Baker and F.Zachariasen.

Phys. Rev., Vol. 118, No. 6, 1659-64 (June 15, 1960).

Pion—pion scattering is calculated using the determinantal method, assuming that a relativistic $(\lambda/4)(\varphi_i\varphi_i)^2$ coupling is responsible for the interaction. The scattering amplitude for the individual partial waves is expressed as a ratio of two power series and terms through λ^3 have been kept in each series. Numerical results for the S and P waves are obtained. λ is adjusted by attempting to fit the electromagnetic structure of nucleons. The best value of λ obtained by this fit is unfortunately so large that the validity of the determinantal approximation is doubtful.

539.12

13029 CHARGE-EXCHANGE SCATTERING OF NEGATIVE PIONS AT 150 MeV. W.J.Kernan.

Phys. Rev., Vol. 119, No. 3, 1092-6 (Aug. 1, 1960).

The charge-exchange scattering of π^- by hydrogen was measured at a bombarding energy of 150 MeV. The energy distribution of gamma rays from the decay of the neutral pions was measured with a lead glass Cherenkov counter at laboratory angles of 45°, 75°, 105° and 135°. If the charge-exchange differential scattering cross-section in the centre of-mass system is expanded as a series of Legendre polynomials, the result is:

$$d\sigma/d\Omega = (1.00 \pm 0.03)[3.39 \pm 0.11-(1.54 \pm 0.29)P_1(\cos\theta')+ +(3.57 \pm 0.56)P_2(\cos\theta')]\text{mb-sr}^{-1}.$$

The total cross-section for charge exchange, obtained by integration, is then $\sigma_{tot}(\pi^- \rightarrow \pi^0) = 42.6 \pm 1.9$ mb.

539.12

13030 CHARGE-EXCHANGE SCATTERING OF NEGATIVE PIONS AT 61 MeV AND 95 MeV.

C.M.York, W.J.Kernan and E.L.Garwin.

Phys. Rev., Vol. 119, No. 3, 1096-9 (Aug. 1, 1960).

The charge-exchange scattering of π^- by liquid hydrogen was measured at 61 ± 1 and 95 ± 2 MeV bombarding energy. The measurements were made with a gamma-ray spectrometer which employs a lead glass Cherenkov counter. If the charge-exchange scattering cross-section is expanded as a series of Legendre polynomials in the centre-of-mass system of the collision, the result at 61 MeV is:

$$d\sigma/d\Omega = (1.00 \pm 0.05)[0.613 \pm 0.030-(0.830 \pm 0.068)P_1(\cos\theta') + +(0.183 \pm 0.150)P_2(\cos\theta')],$$

and at 95 MeV:

$$d\sigma/d\Omega = (1.00 \pm 0.03)[1.05 \pm 0.05-(1.15 \pm 0.12)P_1(\cos\theta') + +(0.33 \pm 0.25)P_2(\cos\theta')].$$

The total cross-section for charge exchange, obtained by integration, is: $\sigma_{tot}(\pi^- \rightarrow \pi^0) = 7.7 \pm 0.6$ mb at 61 MeV and $\sigma_{tot}(\pi^- \rightarrow \pi^0) = 13.2 \pm 0.8$ mb at 95 MeV. A table summarizing the measurements performed by this group at 61, 95, 128 and 150 MeV is given. (For results at 128 MeV, see Abstr. 1296 of 1960).

539.12

13031 P-WAVE RESONANCE IN PION—PION SCATTERING.

B.W.Lee and M.T.Vaughn.

Phys. Rev. Letters, Vol. 4, No. 11, 578-80 (June 1, 1960).

The possible p-wave resonance in pion—pion scattering could be due to a vector boson of isotopic spin one, which interacts with the isotopic vector part of the pion current in the Lagrangian. An expression is derived for the scattering amplitude in the I = 1, J = 1 state. The two parameters describing the resonance are then the mass and coupling constant of the vector boson, rather than the pion—pion and pion—nucleon coupling constants.

A.Ashmore

539.12

13032 A THEORETICAL INTERPRETATION OF ELASTIC π^-—p SCATTERING EXPERIMENTS ON THE J.I.N.R. O.I.Ya.I. SYNCHROPHASOTRON OF THE JOINT INSTITUTE FOR NUCLEAR RESEARCH. I.Patera and Ch.D.Palev.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 987-9 (March, 1960).
In Russian.

From measurements at 7 BeV, and using the optical theorem to estimate the forward scattering amplitude, the elastic scattering phases were deduced using a method of Blochincev [Blokhintsev] et al (Abstr. 512 of 1959). The space distribution of pion absorption on the proton was calculated. The r.m.s. proton radius of 0.83 ± 0.08 fermis agrees with electron-scattering values as well as with π^-—p scattering at 1.3 and 5.0 BeV.

D.W.L.Sprung

539.12

13033 ELASTIC SCATTERING OF 240-330 MeV π^--MESONS ON HYDROGEN. V.G.Zinov and S.M.Korenchenko.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1099-105 (April, 1960).
In Russian.

Presents the results of measurement of the differential cross-sections for elastic scattering of 240, 270, 307 and 333 MeV π^--mesons on hydrogen.

539.12

13034 MOMENTUM SPECTRUM OF π-MESONS FROM $\pi^+ + p \rightarrow 2\pi^+ + n$. V.A.Astaf'ev.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 985-7 (March, 1960).
In Russian.

The reaction is assumed to proceed through the $T = \frac{3}{2}$ resonance. The momentum spectra of particular states are considered. An approximate formulae is derived for the dependence of the matrix element on the angular momenta, l_1, l_2, of the outgoing pions. At the boratory pion energy of 1.37 BeV, calculations indicate that for = l_2 the momentum spectrum has a single maximum, but for creasing $|l_1 - l_2|$ the two-peaked character appears. Since more ates participate in the reaction at high energies, the summed omentum distribution should acquire the two-peaked shape with creasing energy. D.W.L.Sprung

539.12

13035 PANOFSKY RATIO.
N.P.Samios.

hys. Rev. Letters, Vol. 4, No. 9, 470-2 (May 1, 1960).

7000 events were photographed in which π^--mesons stopping in hydrogen bubble-chamber gave rise to Dalitz pairs. Restrictions avoid bias reduced the number to 4199. Separation into the two ategories (π^0 + n and γ + n) was done by means of a momentum-nergy plot. 44 events in the overlap region were assigned according the calculated energy distribution which agreed well with the ex-erimental results. The value obtained for the Panofsky ratio was 62 ± 0.06. The error includes a 1% allowance in calculating the onversion coefficients. A.Ashmore

539.12

13036 NOTE ON THE HIGH-ENERGY TAIL OF THE PION AND γ-SPECTRA IN p—p COLLISIONS AT 25 GeV.
.Hagedorn.

uovo Cimento, Vol. 15, No. 3, 462-4 (Feb. 1, 1960).

The energy distribution of high-energy pions emerging from —p collisions at 25 GeV is estimated using the statistical model. ndications for the calculation of the γ-spectrum from these data re given.

539.12

13037 PION CLOUD EFFECTS IN PION PRODUCTION EXPERIMENTS.
F.Bonsignori and F.Selleri.

uovo Cimento, Vol. 15, No. 3, 465-78 (Feb. 1, 1960).

A simple model is proposed for the study of single pion production collisions of a generic particle "a" on a target nucleon. The model onsists essentially in neglecting all interactions but the one be-ween the incoming particle and a single pion of the nucleon cloud. pplication to a recent pion production experiment in proton—roton collision by the Birmingham group gives support to the ausibility of the idea. Another application to the experiment by e Bologna group gives qualitative evidence of pion—pion inter-tion. Experimental data suggests a pion—pion cross-section of e order of ten millibarns. Finally an experiment is proposed which uld give more detailed information on pion—pion interaction.

539.12

13038 ON THE PRODUCTION OF MESONS IN HYDROGEN AND CARBON ABOVE 10 GeV. II.
.Watase, S.Mitani, K.Suga and Y.Tanaka.

rog. theor. Phys., Vol. 18, No. 3, 314-16 (Sept., 1957).

For Pt I, see Abstr. 3287 of 1956. To study the production of esons in carbon and hydrogen a cloud chamber which contained our pairs of layers of paraffin (3.14 g/cm^2) and graphite (2.68 g/cm^2) nd three lead plates of 1 cm thickness was operated at Mt. Nori-ura (2840 m). The integral energy spectra of photons originating rom neutral pions was obtained and it was found that the slope of he energy spectrum of photons originating from neutral pions roduced by nuclear interactions in paraffin was steeper than that r carbon in the low-energy region, whereas the frequencies of hotons of high energies were nearly the same in the two cases. here was no significant difference in the shapes of the energy pectra of photons between carbon and lead. These facts are ex-lained by the assumption that neutral mesons of low energies pro-uced inside a carbon nucleus are considerably absorbed by secondary ollisions with nucleons in the same nucleus. The angular distri-ution of the secondary particles produced in carbon and paraffin, ith a charged primary particle and without neutral secondary pions, as also studied. It was shown that the azimuthal angular distri-ution of the secondary particles with respect to the direction of a rimary particle, at least in the cases with many secondary parti-les, was anisotropic. This may be explained partly in terms of he fluctuation of secondary interactions in the nucleus.

C.F.Barnaby

539.12

13039 MULTIPLE MESON PRODUCTION BY PHOTONS IN HYDROGEN.
.M.Chasan, G.Cocconi, V.T.Cocconi, R.M.Schectman and D.H.White.

hys. Rev., Vol. 119, No. 2, 811-14 (July 15, 1960).

The analysis of 235 events of double meson production by photons with energy up to 1.1 BeV (reaction $\gamma + p \to p + \pi^+ + \pi^-$) observed in a H_2 diffusion cloud chamber produced the following results. The cross-section rises rapidly at about 500 MeV to a value of approximately 70 μb. The angular, momentum, and Q distributions of the reaction products cannot be satisfactorily accounted for either by a pure statistical model, or by a pure isobaric state model, or by a model assuming interaction of the incoming photon with the meson cloud of the proton, leading to π—π interaction. The observation of 14 cases of the reactions $\gamma + p \to p + \pi^+ + \pi^- + \pi^0$ and $\gamma + p \to n + \pi^+ + \pi^+ + \pi^-$ suggests that the combined cross-section for these reactions is about 10 μb between 700 and 1000 MeV

539.12

13040 PION PRODUCTION IN NUCLEON—NUCLEON COLLISIONS IN BeV RANGE.
T.Kobayashi.

Progr. theor. Phys., Vol. 18, No. 3, 318-20 (Sept., 1957).

A simple model of pion production is assumed in which one nucleon emits a pion which is then scattered by the other nucleon. It is possible to express the production cross-section in terms of the pion—nucleon vertex function and the pion—nucleon scattering cross-section. By using experimental results for the latter, the form of the one-pion production cross-section as a function of energy can be predicted. The results are compared with experiment. E.J.Squires

539.12

13041 PION PRODUCTION IN MUON—NUCLEON COLLISIONS.
G.von Gehlen.

Phys. Rev., Vol. 118, No. 5, 1455-9 (June 1, 1960).

A relation between the differential cross-sections for certain angles and energies of inelastic electron scattering and inelastic muon scattering is given. The asymmetry of the pion production by longitudinal polarized muons is calculated using Fubini—Nambu—Wataghin matrix elements (Abstr. 6174 of 1958).

539.12 : 539.17

13042 THE ENERGY SPECTRUM OF MESONS FROM NUCLEAR DISINTEGRATIONS PRODUCED BY 9 BeV PROTONS.
Yu.T.Lukin, Zh.S.Takibaev and E.V.Shalagina.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1074-7 (April, 1960). In Russian.

The energy of secondary shower particles from stars produced by 9 BeV protons in photographic emulsions was determined. The mean total energy of secondary π-mesons was found to equal (0.78 ± 0.10) BeV and the mean transverse momentum (0.19 ± 0.03) BeV/c. It was found that (40 ± 5)% of the primary proton energy is spent in meson production.

539.12

13043 PHOTOPRODUCTION OF PIONS ON PIONS.
M.Gourdin and A.Martin.

Nuovo Cimento, Vol. 16, No. 1, 78-95 (April 1, 1960).

Photoproduction of pions on pions is computed by means of the Cini—Fubini version of the Mandelstam technique. The problem is reduced to the resolution of a Fredholm integral equation containing an arbitrary multiplicative constant which could be determined by extrapolation of experimental cross-sections. Under the assumption of a sharp pion pion resonance approximate solutions are derived which exhibit the same resonant behaviour.

539.12

13044 PHOTOPRODUCTION OF π^0-MESONS FROM CARBON NEAR THRESHOLD.
R.G.Vasil'kov, B.B.Govorkov and V.I.Gol'danskii.

Zh. eksper. teor.Fiz., Vol. 37, No. 4(10), 1149-51 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 818-19 (April, 1960).

The ratio of the total cross-sections of carbon and hydrogen for photoproduction of π^0-mesons was measured for photon energies of 160, 180 and 200 MeV. Measurements were made on the decay photons at three angles and the angular distributions were then integrated. The results agree with the predictions of elastic photoproduction taking account only of the M($\frac{3}{2}$) amplitude.

A.Ashmore

539.12

13045 TOTAL CROSS-SECTION OF PHOTOPRODUCTION OF π^0-MESONS ON PROTONS AT LOW ENERGIES.
R.G.Vasil'kov and B.B.Govorkov.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 317-18 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 224-5 (Jan., 1960).

Measurements are reported of the total cross-section from threshold to 245 MeV. S.J.Goldsack

539.12

13046 PHOTOPRODUCTION OF CHARGED π-MESONS NEAR THE THRESHOLD.

M.I.Adamovich, É.G.Gorzhevskaya, V.G.Larionova, V.M.Popova, S.P.Kharlamov and F.R.Yagudina.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1028-83 (April, 1960). In Russian.

The differential cross-sections for photoproduction of positive π-mesons on deuterium are also presented. The experimentally derived squares of the matrix elements for π^+- and π^--meson photoproduction on free nucleons, $|K_p|^2$ and $|K_n|^2$, are compared with the theoretical values. The quantity $|K_n|^2$ is compared with the Panofsky ratio and with the meson—nucleon interaction S-phase shifts. The value of the ratio σ^-/σ^+ was obtained in the photon energy range from 153 to 175 MeV.

539.12 : 539.1.07

13047 THE EMISSION OF CHARGED PIONS IN p—p COLLISIONS AT 2.7 GeV. W.M. Bugg and D.T.King.

"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 414-16. In French.

Preliminary results on pion production in p—p interactions in the G5 emulsion are presented. Seven analysable events were found and the reaction products identified. The inelasticity for these events lies between 0.60 ± 0.15 and 0.41 ± 0.11. All collisions are examples of double or triple emission of pions. S.J.St-Lorant

539.12

13048 POSSIBLE PROPERTIES OF D^0-MESONS.

I.V.Chuvilo.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 1002-3 (March, 1960). In Russian.

An isotopic triplet of D-mesons with a mass about 750 MeV is postulated, with the decay scheme $D^0 \rightarrow K + \pi$. An analysis of over 50 anomalous V^0-decays in cosmic-ray events suggests the existence of two neutral cascade mesons D_1^0 and D_2^0 with Q-values 38 and 63 MeV. They form about 1-2% of the neutral K- and Λ-current, and decay in one-to-one ratio into the positive and negative pion channels. D.W.L.Sprung

539.12

13049 THE K_{e4} AND $K_{\mu 4}$ MODES OF K-MESONS DECAY.

V.S.Mathur.

Nuovo Cimento, Vol. 14, No. 6, 1322-31 (Dec. 16, 1959).

The characteristics of the K_{e4} and $K_{\mu 4}$ modes of K-meson decay are studied. Isotopic spin relationships following from the hypothesis of a $T = \frac{1}{2}$ strangeness-nonconserving current are discussed. The decay rates have been estimated in several ways, which agree in predicting a K_{e4}^+/K_{e3}^+ branching ratio between 10^{-3} and 10^{-4}, so that the observation of K_{e4}^+ events may be expected in the near future. The $K_{\mu 4}^+$ rate is expected to be at least an order of magnitude smaller than that for K_{e4}^+ mode of decay.

539.12 : 539.14

13050 HYPERFRAGMENTS PRODUCED BY K^- CAPTURE IN NUCLEAR EMULSION: π^0 DECAY MODES. R.G.Ammar.

Nuovo Cimento, Vol. 14, No. 6, 1226-48 (Dec. 16, 1959).

This is a systematic study of the π^0-decays of light hyper-nuclei ($A \leq 5$) produced by K^- capture in nuclear emulsion. Approximately 3×10^4 K^- stars were examined, yielding a total of 94 1-prong events satisfying the following conditions: $R_c \geq 5\,\mu m$, $8\,\mu m \leq R_0 \leq 50\,\mu m$, $\theta \geq 66^0$, where R_c is the range of the primary (connecting track), R_0 that of the secondary (recoil) and θ the angle between their directions at their point of intersection. Of the 69 events which could be charge (Z) identified, 55 had Z = 1 and 14 Z = 2. In the Z = 1 category the true π^0-events could not be separated from 1-prong Σ^--events because of the overwhelming (≥ 90%) contribution of the latter. It is concluded that probably all the 14 Z = 2 events represent true ${}_\Lambda He$ decays (~10 ${}_\Lambda He^4$ and ~4 ${}_\Lambda He^5$). In addition, three 2-prong events were consistent with the interpretation as ${}_\Lambda He^4$ decays. One can define for the π^0-decays of ${}_\Lambda He^4$ the ratio: $R'({}_\Lambda He^4)$ = (two-body decays)/(all decays — "unobservable" ones); the "unobservable" ones being π^0-neutron-recoil decays with recoil momenta < 110 MeV/c and other modes with ≥ 1 neutron. A value $R'({}_\Lambda He^4) = 0.82^{+0.18}_{-0.18}$ is found here. The analogous quantity for ${}_\Lambda H^4$ was computed from other data and yields $R'({}_\Lambda H^4) = 0.88^{+0.07}_{-0.06}$. These two numbers are equal within their experimental errors. This equality is consistent with the assumption $|p_-/s_-| = |p_0/s_0|$ as predicted by the $\Delta T = \frac{1}{2}$ rul The ratio, ρ of two-body π^0-decays of ${}_\Lambda He^4$ to the total number of π^--decays of ${}_\Lambda He^4$ was determined to be 0.7 ± 0.4. According as the spin of ${}_\Lambda He^4$ is 0 or 1, ρ is a measure of the strength either of the s- or of the p-wave channel in the neutral mode of the free Λ decay.

539.12

13051 K^-—DEUTERON SCATTERING AND THE K^-—NUCLEO SCATTERING LENGTHS.

T.B.Day, G.A.Snow and J.Sucher.

Phys. Rev., Vol. 119, No. 3, 1100-2 (Aug. 1, 1960).

Cross-sections for K^-—d reactions are calculated in the low-momentum region for several possible values of the elementary K—nucleon scattering amplitudes. Multiple-scattering effects are included in an approximate way. A comparison of the results for the sum of the elastic plus breakup cross-sections with the preliminary measurements available is presented.

539.12

13052 PION—PION SCATTERING AND $K^\pm \rightarrow 3\pi$ DECAY.

N.N.Khuri and S.B.Treiman.

Phys. Rev., Vol. 119, No. 3, 1115-21 (Aug. 1, 1960).

The effects of final-state pion—pion interactions on the spectru of $K^\pm \rightarrow 3\pi$ decay is studied by dispersion relation methods. In the approximations adopted a set of linear integral equations is derived for the amplitudes of the $K^\pm \rightarrow 3\pi$ decay. The kernels in these equations depend on the pion—pion S-wave scattering amplitudes. An approximate solution for these equations is obtained by iteration and the departures from a purely statistical spectrum for the decay are related to pion—pion S-wave scattering. The latter in turn is assumed to be well represented with a scattering length structure. The $K^\pm \rightarrow 3\pi$ spectrum then is parametrized by two quantities, the T = 0 and T = 2 pion—pion S-wave scattering lengths, a_0 and a_2. Such experimental results as presently exist indicate that $a_2 - a_0$ is positive and that roughly $a_2 - a_0 \approx 0.7$, in units of the pion Compton wavelength.

539.12

13053 FINAL-STATE INTERACTIONS AND $|\Delta I| = \frac{1}{2}$ SELECTION RULE. K.Chadan and S.Oneda.

Phys. Rev., Vol. 119, No. 3, 1126-7 (Aug. 1, 1960).

The effect is considered of various isotopic spin selection rules and final-state interactions between two outgoing pions upon the K_{e4}/K_{e3} branching ratio.

539.12

13054 DISPERSION RELATIONS FOR K-MESON—NUCLEON SCATTERING. K.Igi.

Progr. theor. Phys., Vol. 19, No. 3, 238-48 (March, 1958).

The dispersion relations are derived by analogy with pion—nucleon scattering. Assuming K-meson spin to be zero, an essential difference is found between the dispersion relations for K-mesons with the two types of interaction: scalar and pseudoscalar. The contributions to the scattering amplitude arising from the unphysical region, due to the exothermic reactions $K + p \rightarrow \pi + \Lambda$ and $K + p \rightarrow \pi + \Sigma$, are discussed.

539.12

13055 DISPERSION RELATION FOR K-MESON—NUCLEON SCATTERING AND ITS APPLICATION. K.Igi.

Progr. theor. Phys., Vol. 20, No. 4, 403-9 (Oct., 1959).

The dispersion relation is used for analysing K—N scattering data to determine the type of the K-coupling and the magnitude of its coupling constant. The following assumptions are made: (a) the K-meson spin is zero; (b) Λ and Σ have the same parities; (c) the K^+— interaction is repulsive; (d) K—p scattering at low energies is isotropic. It is concluded that if the K^-—p interaction is repulsive, K-coupling is scalar; if K^-—p is attractive, the coupling could be either scalar or pseudoscalar, depending on the energy dependence of the $K^\pm$—p scattering cross-section at low energies.

539.12

13056 ANALYSIS OF K^- ABSORPTION IN DEUTERIUM.

T.Kotani and M.Ross.

Nuovo Cimento, Vol. 14, No. 6, 1282-1309 (Dec. 16, 1959).

The capture of K^- at rest by deuterium has been examined theoretically, principally in terms of final state YN interactions. In particular total rates were calculated, the momentum spectra associated with the production of $\Sigma^- + n + \pi^+$ and $\Lambda^0 + p + \pi^-$, and the corresponding angular correlation. (The latter are not found

›e useful except perhaps as a check). On the basis of total rates
s known that capture from the P Bohr orbit through the s wave
channel probably dominates. This assignment is reinforced by
spectrum of the low momentum Λ peak (Λ's converted from Σ's).
efinite check can be made when a somewhat better converted Λ
ctrum is measured, since one should observe a double peak (with
usp at the maximum pion momentum associated with production)
his assignment is correct. Analysis of the high pion momentum
eak (directly produced Λ's), using this assignment reveals that
spectrum is insensitive to the YN interaction and yet does not
m to agree with the data. This spectrum shape (and that for
$n\pi^+$) depends significantly on the KN → Yπ absorption process off
energy shell, which in turn depends on the KN scattering lengths.
eliminary comparison of data and theory indicates a large negative
l part for the isotopic spin one KN scattering length. Finally,
m the relative rate for conversion of Σ's into Λ's, is deduced
ninimum value for the imaginary part of the isotopic spin $\frac{1}{2}$p wave
scattering length The result, larger than the pion Compton
ve-length, indicates a very strong potential in the ΣN channel
/or coupling ΣN and ΛN channels, a potential much stronger than
icated by the universal pion baryon interaction. Capture from
S Bohr orbit is also extensively discussed. In this case, the
ctra associated with Σ^- and direct Λ production are sensitive
he final YN interaction.

539.12 : 539.14

MECHANISM OF K^- ABSORPTION IN NUCLEI. See Abstr.
94

539.12

13057 GLOBAL SYMMETRY AND THE BRANCHING RATIOS FOR THE K^- CAPTURE BY THE NUCLEON.

Kawarabayashi.
ogr. theor. Phys., Vol. 20, No. 2, 117-25 (Aug., 1958).

Branching ratios for K^- capture by the nucleon are studied to
estigate the validity of Gell-Mann's global symmetry (Abstr. 7408
1957). The following assumptions are made: (a) Gell-Mann's
bal symmetry is valid; (b) the K-meson is pseudoscalar; (c) mass
ferences among baryons can be neglected, and (d) processes involving K mesons are described by treating the M. S coupling as
rturbations in the lowest order that gives the effect. Under these
sumptions, the matrix element for the above processes are expressed in terms of the π—N scattering matrix elements for which
perimental data can be used. The branching ratios are compared
h experimental results.

539.12

13058 METHOD FOR DETERMINING THE ORBITAL ANGULAR MOMENTUM IN K^-—d CAPTURE. D.H.Miller.

ys. Rev. Letters, Vol. 4, No. 11, 568-70 (June 1, 1960).

The reaction $K^- + d \rightarrow \Sigma^- + p$ is known to occur to the extent of
% for K^- captured at rest. This enables the matrix element to be
luated for either S-orbital or P-orbital capture. The two cases
l give different energy dependence for capture in flight. This
pendence is calculated for momenta up to 300 MeV/c, and
icates that low statistical accuracy would distinguish the two
ses. A.Ashmore

539.12

13059 THE PRODUCTION RATIO OF K^+ TO K^- MESONS.

Y.Kakudo and K.Kobayakawa.
ogr. theor. Phys., Vol. 17, No. 6, 823-5 (June, 1957)

The ratio of K^+ to K^- mesons produced in proton and pion colions on nuclei is calculated using the statistical theory in an apoximate form. The values obtained are in agreement with the
ailable experiments. Ratios of $\Sigma^0 + \Lambda^0$ to $\Sigma^- + \Sigma^+$ are also
lculated. E.J.Squires

perons

539.12 : 539.11

$\Lambda \rightarrow N + \pi$ DECAY AND THE $|\Delta I| = \frac{1}{2}$ RULE. See Abstr. 12839

539.12

13060 PHENOMENOLOGICAL ANALYSIS OF THE DECAY PROCESSES OF THE Σ- AND Λ-HYPERONS.

Yamaguchi.
ogr. theor. Phys., Vol. 19, No. 5, 485-94 (May, 1958).

The decays are discussed on the basis of the $\Delta I = \frac{1}{2}$ law. In particular, the asymmetry coefficients of the pion coming from the hyperon decay are expressed in terms of ratios of partial decay rates of Σ^+- and Σ^--hyperons, and these are useful to test the original assumption of the $\Delta I = \frac{1}{2}$ law. The connection between the Σ- and Λ-decay interactions is also mentioned briefly.

539.12

13061 HYPERON DECAYS AND CHARACTERISTICS OF INTERACTIONS BETWEEN ELEMENTARY PARTICLES.

Y.Taguchi and R.Kawabe.
Prog. theor. Phys., Vol. 19, No. 5, 586-9 (May, 1958).

The interaction Hamiltonian for the weak decays of the hyperons is formulated and the distribution functions for the decay products evaluated. Experimental results are briefly discussed within the theoretical framework. S.J.St-Lorant

539.12

13062 ISOTOPIC SPIN SELECTION RULE IN Σ-DECAYS.

T.Eguchi and S.Nagata.
Progr. theor. Phys., Vol. 20, No. 2, 144-8 (Aug., 1958).

Use is made of the branching ratio, lifetimes and asymmetries of the angular distributions in Σ-decays to show that the selection rule $|\Delta I| = \frac{1}{2}$ is consistent in the decays of Σ-hyperons as well as in the Λ-decays. The invariance under time reversal is assumed, and the asymmetry parameters, the average degrees of polarization of Σ and the ratios of the coupling constants are obtained.

539.12

13063 POSSIBLE EXPERIMENTAL TESTS ON THE DECAY INTERACTIONS OF HYPERONS. K.Itabashi.

Progr. theor. Phys., Vol. 20, No. 4, 457-75 (Oct., 1958).

A study is made of what information could be obtained by measurements of the $(N + \pi)$ decays of Σ- and Λ-hyperons. In particular, the possibility of experimental tests for the $|\Delta I| = \frac{1}{2}$ rule and the postulate of time-reversal invariance is discussed. The paper also discusses whether the relative magnitudes of the effective strengths of the $|\Delta I| = \frac{1}{2}$ and other interactions (if they exist) could be determined under suitable assumptions on the dynamical nature of the interactions. Some physically interesting examples of such assumptions are presented and it is shown that the validity of those assumptions can be tested experimentally. To obtain definite information, it is very desirable to measure, at least, the ratio of the asymmetry parameters for various modes of decays.

539.12

13064 POSSIBLE EVIDENCE FOR THE RADIATIVE DECAY OF THE Σ^+ HYPERON. E.M.Friedländer.

Phys. Rev. Letters, Vol. 4, No. 10, 528-30 (May 15, 1960).

Describes an event, found in G5 emulsion exposed to the Bevatron K^--beam, most likely interpreted as a three-body decay of a Σ^+-hyperon, $\Sigma^+ \rightarrow n + \pi^+ + \gamma$. S.J.St-Lorant

539.12

13065 LEPTON DECAYS OF HYPERONS WITH EMISSION OF π-MESONS. I.S.Tsukerman.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1285-7 (April, 1960).
In Russian.

The total probabilities for lepton decays of hyperons with emission of a π-meson, $Y \rightarrow N(Y') + l + \nu + \pi$ (l denotes an electron or a μ-meson) are estimated in the case of the simplest matrix element of the universal V—A-interaction for one of the possible diagrams of perturbation theory.

539.12

13066 PROPOSAL FOR DETERMINATION OF $\Sigma\Lambda$ RELATIVE PARITY FROM CHEW AND LOW ANALYSIS OF REACTIONS OF THE FORM A + B → C + D + E + ...

M.Muraskin.
Phys. Rev., Vol. 119, No. 2, 818-21 (July 15, 1960).

The Chew and Low analysis (Abstr. 7241 of 1959) of reactions of the form A + B → C + D + E + ..., which makes use of the existence of a pole in the S matrix, is employed to propose an experiment to determine the Σ—Λ relative parity and the coupling constant for the $\Sigma\Lambda\pi$ interaction. It is found that the sign of the extrapolated cross-section for the reaction $\Sigma^+ + d \rightarrow \Lambda^0 + p + p$ is different for the two parity cases. Other applications of the Chew and Low method to strange-particle reactions are briefly discussed.

539.12

13067 EVIDENCE FOR THE REACTION $\bar{p} + p \rightarrow \bar{\Sigma}^0 + \Lambda$. J.Button, P.Eberhard, G.R.Kalbfleisch, J.E.Lannutti, G.R.Lynch, B.C.Maglić and M.L.Stevenson.
Phys. Rev. Letters, Vol. 4, No. 10, 530-3 (May 15, 1960).

An event found in a 72 in. liquid hydrogen chamber, exposed to a highly purified beam of antiprotons of 1.99 ± 0.03 GeV/c momentum is described and its possible interpretation discussed in terms of a hyperon—antihyperon reaction. S.J.St-Lorant

Strange particles

539.12 : 539.17

13068 PRODUCTION OF STRANGE PARTICLES IN THE INTERACTION BETWEEN 9 BeV PROTONS AND EMULSION NUCLEI. N.I.Kostanashvili and O.A.Shakhulashvili.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1006-11 (April, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 4, 713-16 (Oct., 1959).

Type BR-450 emulsion yielded 1920 stars and 670 secondary particles. Of these slow secondaries in the forward direction, 6 were strange particles and 19 π^+ or π^- mesons. The cross-section for star formation was about 460 millibarns, and for slow strange particles about 20 millibarns. Analysis are given of the 25 strange particles found by line and area scanning. E.J.Burge

539.12

13069 BETA-DECAY OF STRANGE PARTICLES. V.M.Shekhter.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1299-301 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 920-1 (Oct., 1959).

The effective coupling constant for the β-decay of hyperons is determined from a study of K_{e_3} and K_3 decays. The results suggest that the appropriate four-fermion coupling constant is about 0.1 times the corresponding constant for ordinary β-decay. Predictions are given for expected decay rates for leptonic decays of hyperons, which are within the experimental limits. R.F.Peierls

539.12

13070 ON THE SIGNIFICANCE OF STRANGE PARTICLES IN FERMI'S STATISTICAL THEORY.
V.I.Ruskin and P.A.Usik.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 929-34 (March, 1960). In Russian.

It is shown that allowance for resonance interaction of two π-mesons in Fermi's statistical theory explains a number of experimental facts which remained inexplicable on the statistical theory which takes into account only the nucleon "isobar" ($^3/_2$, $^3/_2$). Such facts are: the mean multiplicity of π- and K-mesons in $p\bar{p}$-annihilation, mean multiplicity of strange particles in meson—nucleon collisions, angular correlations between π-mesons in π^-p-interactions at an energy of 1.0 BeV.

Deuterons

539.12

13071 RE-EVALUATION OF THE ELECTRIC QUADRUPOLE MOMENT OF THE DEUTERON.
H.Narumi, T.Watanabe and O.Nakahara.
Progr. theor. Phys., Vol. 19, No. 5, 591-2 (May, 1958).

Some preliminary results on the recalculation of the quadrupole moment of the deuteron using the James—Coolige 11-term wave function are presented. S.J.St-Lorant

539.12

13072 ELASTIC SCATTERING OF DEUTERONS BY He^4. J.L.Gammel, B.J.Hill and R.M.Thaler.
Phys. Rev., Vol. 119, No. 1, 267-71 (July 1, 1960).

A model of the d + He^4 interaction is developed and compared to data on the ground state of Li^6 and the d + He^4 elastic scattering data up to 4.5 MeV (deuteron laboratory energy). New phase-shift analyses of the 8 and 10.3 MeV elastic scattering data are made, and quantities relevant to the production or analysis of beams of polarized deuterons are calculated.

Tritons

539.12

13073 SCATTERING OF PROTONS ON TRITONS AT SMALL ENERGIES.
Yu.G.Balashko, I.Ya.Barit and Yu.A.Goncharov.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1937-9 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1378-9 (Dec., 1959).

Measurements of elastic p—T scattering were carried out in the energy interval 50-200 keV, using incident tritons. Assuming only s-wave scattering a phase-shift analysis was performed. The result cannot be accounted for by pure potential scattering, and show resonance behaviour in the singlet s-state which could be accounted for by the existence of a level in He^4 with an excitation energy of about 20 MeV. J.D.Dowell

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

537.59

13074 EXPERIMENTS ON COSMIC RADIATION BY MEANS OF ARTIFICIAL SATELLITES. C.F.Powell.
Proc. Roy. Soc. A, Vol. 253, 482-7 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (see Abstr. 8520 of 1960). In this review an account of the main facts about the cosmic radiation as they are at present known is given and the outstanding problems which await solution are discussed. Some of the advantage offered by an artificial satellite are distinguished and a few of the problems to which a satellite programme could make a valuable contribution are reveiwed. C.F.Barnaby

537.59

13075 ACCELERATION OF COSMIC RAYS BY HYDROMAGNETIC WAVE.
Y.Terashima, K.Kitao and K.Ogawa.
Progr. theor. Phys., Vol. 17, No. 6, 814-15 (June, 1957).

It is shown that when a charged particle encounters a hydromagnetic wave in an ideal incompressible fluid the fractional energy gain per collision is proportional to the square of the wave velocity and not of the fluid velocity. In the case of the spiral arm of the Galaxy and particularly of the Crab Nebula this would lead to an acceleration higher by an order of magnitude than if the fluid velocity were substituted, but would still be lower than required by cosmic ray data. E.W.Kellermann

537.59

13076 ON THE RELATIVE ABUNDANCES OF COSMIC RAY NUCLEI OF CHARGE $Z \geq 3$.
C.M.Garelli, B.Quassiati and M.Vigone.
Nuovo Cimento, Vol. 15, No. 1, 121-9 (Jan. 1, 1960).

The charge spectrum of heavy primaries ($Z \geq 3$) of cosmic radiation was measured in nuclear emulsion exposed in a high altitude balloon flight at a residual atmospheric thickness of about 6 g/cm^2. The fluxes of light, medium and heavy nuclei at the top of the atmosphere, and also the relative abundances of charges between Z = 3 and Z = 14, are given.

537.59

13077 HIGH ENERGY GAMMA-RAYS FROM THE CRAB NEBULA. S.Hayakawa.
Progr. theor. Phys., Vol. 19, No. 2, 219 (Feb., 1958).

The Burbidge model of the Crab nebula (1958) requires a photon intensity of $\sim 3 \times 10^{-6}$ cm^{-2} sec^{-1} at the top of the terrestrial atmosphere, equivalent to a particle energy of $\sim 10^{-2}$ cm^{-2} sec^{-1}. Thus photons from the nebula might be detected with nuclear emulsions as cascade showers unaccompanied by charged pions. Similar showers have already been observed (1954, 1956), and a re-discussion of these results is needed in attempting an identification of the photons responsible for the shower with those from the Crab nebula. D.R.Barber

537.59 : 551.5

13078 TEMPORARY CAPTURE OF COSMIC RAY PARTICLES AND THEIR CONTRIBUTION TO THE HIGH INTENSITY BELTS. R.Gall and J.Lifshitz.
Nuovo Cimento, Vol. 15, No. 2, 233-45 (Jan. 16, 1960).

The theory of the temporary permanence of charged particles the vicinity of unstable periodic orbits in the earth's magnetic ld is discussed in relation to the high-intensity belts surrounding earth. The intervals of energies of protons temporarily ıpped by this mechanism are calculated for various latitudes and stances. Several possible sources of charged particles and their ntribution to the high intensity belts are discussed. The intensity e to the temporary capture of primary cosmic-ray protons is lculated. The theoretical intensity curves are compared with the perimental curves taken aboard Pioneer III. The secondary albedo otons spectrum is deduced. Theoretical isointensity curves for ptured primary and secondary protons are plotted for the distances om 2 to 8 earth's radii.

537.59

13079 DISINTEGRATION OF COSMIC-RAY NUCLEI BY SOLAR PHOTONS. N.M.Gerasimova and G.T.Zatsepin.
. eksper. teor. Fiz., Vol. 38, No. 4, 1245-52 (April, 1960).
Russian.

A calculation is made of the effect of disintegration of cosmic- y nuclei in the field of solar photons leading to formation of cor- lated showers in the atmosphere. The energy of the disintegrated clei is found to be of the order of 10^{16} eV per nucleon and their flux of the order of 10^{-4} - 10^{-3} km^{-2} hr^{-1} sterad^{-1}. As a result of di- rgence of the photonuclear disintegration products before they ter the atmosphere the distances between the cores turn out to be the order of approximately 1 km.

537.59

13080 SIZE-SPECTRUM OF EXTENSIVE AIR SHOWERS OF THE COSMIC RADIATION. I. RESPONSE OF A SINGLE :INTILLATOR TO EXTENSIVE AIR SHOWERS. J.R.Green.
ıovo Cimento, Vol. 14, No. 6, 1342-55 (Dec. 16, 1959).

Previously determined experimental and theoretical expressions the lateral distribution of particles in extensive air showers are ed to predict the response of a single scintillator to these showers. ie integral rate of particles traversing the scintillator is found in rms of the integral rate of showers; the average size of shower sulting in a given number of particles through the scintillator is lculated; the effect of the zenith-angle distribution of the shower es is also investigated.

537.59

13081 SIZE-SPECTRUM OF EXTENSIVE AIR SHOWERS OF THE COSMIC RADIATION. II. EXPERIMENTAL ESULTS FROM A SINGLE SCINTILLATOR.
R.Green and J.R.Barcus.
ıovo Cimento, Vol. 14, No. 6, 1356-65 (Dec. 16, 1959).

The operation and calibration of a single scintillator of area 3 m^2 is discussed. The integral spectrum of particles passing rough the scintillator at 1575 m.s.l. has a logarithmic slope of (1.514 ± 0.022); from this it is deduced that the integral spectrum extensive air showers whose sizes lie in the range from 10^5 to ^{8} particles is given by $K(\geq N) = 3.2\times10^{-7}(N/10^6)^{-1.514}$ m^{-2} sec^{-1}sr^{-1} naller events are identified with stars produced locally in the luene of the scintillator; the integral spectrum of such events ssipating E MeV in the scintillator is given by $R(\geq E) = 4.5\times10^2$ $^{-2.76}$ min^{-1}/g of toluene.

537.59

13082 THE ANGULAR DISTRIBUTION OF SECONDARY PARTICLES IN HIGH ENERGY NUCLEAR COLLISIONS ITH HEAVY NUCLEI OF PHOTOGRAPHIC EMULSION.
Bartke, P.Ciok, J.Gierula, R.Holyński, M.Mięsowicz and Saniewska.
ıovo Cimento, Vol. 15, No. 1, 18-24 (Jan. 1, 1960).

61 jets produced by singly charged and neutral particles of osmic radiation in photographic emulsion in collisions with heavy ıclei ($N_h > 8$) have been investigated. Primary energies and nisotropy parameters for angular distributions of secondary articles have been calculated. The results are compared with those reviously obtained for events with small evaporation ($N_h \leq 5$). It ight be stated that the energy dependence of the anisotropy for oth samples of jets is similar. The mean anisotropy is however naller than that predicted by hydrodynamical theories. It is ated that in the same energy interval the anisotropy for particular vents differ very much and that the main contribution to high aniso- ropy is given by the cases in which the angular distribution N/d (log tg θ) is not a normal one, but shows two separated maxima. he results are discussed from the point of view of the two-centre odel.

537.59

13083 ARRIVAL DIRECTIONS OF COSMIC-RAY AIR SHOWERS FROM THE EQUATORIAL SKY.
E.V.Chitnis, V.A.Sarabhai and G.Clark.
Phys. Rev., Vol. 119, No. 3, 1085-91 (Aug. 1, 1960).

The celestial arrival directions of over 100 000 showers with sizes greater than 10^5 particles were determined by fast timing in observations at an altitude of 2034 m. The observations covered a band of declinations from $-30°$ to $+50°$ with an angular resolution of $4°$, and they extend a survey that covered the northern sky (Abstr. 1110 of 1957). As in the earlier experiment no significant deviation from isotropy was found. The atmospheric attenuation of the shower intensity was determined from the zenith angle distribution, and also from a comparison of the absolute shower intensity at 2034 m and at sea level. Within an experimental uncertainty of about 5%, both methods yield an exponential attenuation length consistent with the value of 107 g cm^{-2} previously found at sea level. The absolute intensity of showers with more than 10^5 particles at 2034 m was found to be $(1.11 \pm 0.30)\times10^{-9}$ cm^{-2} sec^{-1} sr^{-1}.

537.59

13084 THE ENERGY OF THE ELECTRON—PHOTON COMPONENT OF EXTENSIVE AIR SHOWERS.
S.N.Vernov, V.A.Dmitriev, V.I.Solo'eva and G.B.Khristiansen.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1481-2 (Nov., 1959).
In Russian.

The mean energy per particle of the component has been measured near sea-level [cf. previous paper by this group (Abstr. 9467 of 1960)]. The result is:

$E = 10^9\ r^{-(0.6\pm0.1)}$ eV $0.1\ \mathrm{m} \leq r \leq 30\ \mathrm{m}$

$E = (1.2 \pm 0.15)\times10^8$ eV $100\ \mathrm{m} \leq r \leq 1000\ \mathrm{m}$

Comparison with Nishimura—Kamata theory (s = 1) shows that the observed increase in the mean energy towards the shower axis is slower than the theoretical increase. On the other hand, the mean energy on the periphery of the shower is higher than theoretical.
S.Chomet

537.59

13085 ON AN ESTIMATE OF ENERGY CHARACTERISTICS OF SHOWER-PRODUCING PARTICLES.
É.G.Boos and Zh.S.Takibaev.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 292-3 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 206-7 (Jan., 1960).

A new method estimating the energy of cosmic ray "jets" by including an assumption of constant transverse momentum is discussed, and the results are compared with other methods for typical stars.
S.J.Goldsack

537.59

13086 THE DEPENDENCE OF THE THREE-DIMENSIONAL DEVELOPMENT OF A CASCADE SHOWER ON THE ENERGY OF THE PRIMARY PARTICLE.
V.V.Guzhavin and I.P.Ivanenko.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 662-4 (Feb., 1960). In Russian.

It is shown how the formulae for the three-dimensional development of a cascade shower, which were derived on the assumption that the primary particle has infinite energy, are modified when the finite energy of the primary particle is taken into account in a consistent way. Detailed calculations are to appear in a later paper.
D.J.Thouless

537.59

13087 AN EXPERIMENTAL INVESTIGATION OF THE ENERGY SPECTRUM OF THE PENETRATING COMPONENT OF EXTENSIVE AIR SHOWERS. É.L.Andronikashvili and R.E.Kazarov.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 703-7 (March, 1960).
In Russian.

The energy spectrum of the μ-meson component of extensive air showers was studied in the range from 0.4 to 37 BeV. The investigations were performed for three groups of showers possessing a mean particle number of 1.4×10^4, 7×10^4 and 2.9×10^5. The energy spectrum at an average distance of ~28 m from the axis was plotted for the three types of showers. The energy spectrum of the shower as a whole was also determined. For all three shower groups the power exponent is approximately equal to one.

537.59

13088 MOMENTUM SPECTRUM AND POSITIVE EXCESS OF μ-MESONS. J.Pine, R.J.Davisson and K.Greisen.
Nuovo Cimento, Vol. 14, No. 6, 1181-204 (Dec. 16, 1959).

The absolute spectrum and positive excess of cosmic-ray μ-mesons near sea level were measured in the range 2 to 175 GeV/c. The magnetic spectrometer and the method of data reduction are described in detail. The integral spectrum has been compared with the range distribution in the earth, and the agreement indicates that there is no serious error in the theoretical expression for the rate of energy loss. The π-meson production spectrum has been computed and found to fit a power law with exponent −2.64. Also the spectrum of the pion positive excess has been obtained, which is related to the pion production by primary protons in their first collisions. It is concluded that at 10^{12} eV per nucleon, most of the primary cosmic-ray energy is carried by protons, and that the proportion of their energy given to pions in a single interaction is in the neighbourhood of 10%.

537.59 : 539.1.07

13089 THE ENERGETIC DELTA-RAY METHOD APPLIED TO THE MEASUREMENT OF ENERGIES OF HEAVY COSMIC-RAY PARTICLES. J.Hébert.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 440. In French.

A reasonably accurate estimation of the energy of a heavy primary nucleus is obtained from measurements of the maximum delta-ray energy and the angle of emission of such δ-rays relative to the direction of the primary particle. An illustration of the method is given for a particular nucleus. S.J.St-Lorant

537.59 : 539.1.07

13090 THE ABSORPTION OF COSMIC RAYS IN LEAD MEASURED WITH NUCLEAR EMULSIONS.
A.I.McPherson and V.M.Forbes.
"Particle photography" Conference. Montreal, 1958 (see Abstr. 2261 of 1960) p. 441. In French.

Contains only the discussion of the above paper.
S.J.St-Lorant

537.59

13091 ON THE NORTH—SOUTH ASYMMETRY OF COSMIC RAYS NEAR SEA LEVEL AT GREAT ZENITH ANGLES IN HIGH LATITUDES. V.Hovi and A.Aurela.
Ann. Acad. Sci. Fennicae A VI, No. 46, 6 pp. (1960).

The N—S asymmetry of ionizing cosmic rays was measured at Turku, Finland, in the geomagnetic latitude of 58.3°N and at an altitude of 49 m above sea level at the zenith angle of 80°. The result obtained, $A_{ns} = 0.107$, supports Burbury's view (Abstr. 5887 of 1952) of the origin of this asymmetry. Additional observations are in progress.

537.59

13092 THE STUDY OF COSMIC RAY VARIATIONS WITH NUCLEAR EMULSIONS. C.J.Waddington.
Nuovo Cimento, Vol. 14, No. 6, 1205-16 (Dec. 16, 1959).

It is shown that the density of ending particles observed in nuclear emulsions exposed at high altitudes is related to the primary cosmic-ray flux. Because this is a parameter which is readily determined it is suggested that its use is particularly appropriate for studying temporal variations of the primary radiation. The necessary corrections for background particles are established, and preliminary applications illustrated. A value is obtained for the exponent of the primary energy spectrum during solar maximum, and relations derived relating this parameter to the flux of primary cosmic ray α-particles.

537.59

13093 SOLAR FLARE EFFECTS ON COSMIC RAY INTENSITY. H.Ghielmetti, J.C.Anderson, J.M.Cardoso, J.R.Manzano, J.G.Roederer and O.R.Santochi.
Nuovo Cimento, Vol. 15, No. 1, 87-98 (Jan. 1, 1960).

In order to look for small cosmic-ray increases associated with the development of solar flares, data from two neutron monitors located in the Southern Hemisphere were analysed. Solar flares of magnitude 2 or greater were selected, and the analysis was carried out for the detectors being located within the morning impact zones. The behaviour of nucleonic intensity, corrected for superposed daily variation, did not show any significative increase over the "zero hour". This result contrasts with that of Firor, but agrees with the more recent paper by Towle and Lockwood. However, in the present work and for one station, there appears a significative peak if another type of correction is applied. Furthermore, another significative increase arises several hours after the onset of solar flares, closely peaked around the time of maximum in the mean daily variation. Data examined were extracted from records of the University of Tasmania at Mount Wellington (Hobart, Tasmania) and Mawson (Antarctica). The period investigated covers from July 1957 to August 1958.

537.59

13094 LARGE COSMIC-RAY INTENSITY FLUCTUATIONS IN THE STRATOSPHERE.
A.N.Charakhch'yan, V.F.Tulinov and T.N.Charakhch'yan.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1031-6 (April, 1960).
In Russian.

The energy spectrum of an additional proton flux, which exceeded the normal value more than 20 times, was derived from stratospheric measurements. The exponent of the differential spectrum was equal to 6.0 in the 120-170 MeV energy range. It is suggested that these protons are due to corpuscular beams with frozen-in magnetic fields emitted during the solar chromosphere flare on May 10, 1959.

537.59

13095 ON THE RADIATION OF MESONS WITH A CONSTANT TRANSVERSE MOMENTUM P_t IN COSMIC RAY JETS.
G.Yekutieli.
Nuovo Cimento, Vol. 13, No. 2, 446-7 (July 16, 1959).

The constant transverse momentum and the momentum spectrum of mesons produced in cosmic ray jets can be accounted for by assuming that meson production in these events is due to a mesonic Cherenkov radiation in nuclear matter. Using a constant, real forward-scattering amplitude for the mesonic waves and a Cherenkov-like energy spectrum the principal features of cosmic-ray jets may be deduced from the optical model. E.G.Michaelis

537.59

13096 INVESTIGATION OF A HIGH ENERGY ELECTRON—PHOTON CASCADE IN EMULSION.
E.Fenyves, A.Frenkel, F.Telbisz, J.Perneger, V.Petržílka, J.Sedlák and J.Vrána.
Nuovo Cimento, Vol. 14, No. 6, 1249-53 (Dec. 16, 1959).

A photon initiated high-energy electron—photon cascade was investigated. The energy of the primary photon was determined from the longitudinal development and the lateral distribution of the cascade to be about 2×10^{12} eV. The energy spectrum of electron pairs generated on the first 1.5 cascade units was measured. The spectrum obtained does not deviate significantly from either the spectrum calculated by the Bethe—Heitler theory or from that calculated by Migdal extending the Landau—Pomeranchuk—Ter—Mikaelyan theory.

537.59

13097 DISTRIBUTION OF THE TRANSVERSE MOMENTUM OF SHOWER PARTICLES IN JETS.
E.G.Boos and Zh.S.Takibaev.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1276-84 (April, 1960).
In Russian.

Experimental data are presented on the distribution of the transverse momentum values of secondary shower particles in jets produced by cosmic rays. Transverse momentum distributions which follow from various phenomenological descriptions of multiple production of mesons are analysed and systematized. Comparison with the experiment narrows the possible choice of a scheme for description of the elementary multiple-meson-production process.

537.59 : 539.17

13098 YIELD OF NEUTRONS PER INTERACTION IN U, Pb, W, AND Sn BY PROTONS OF SIX ENERGIES BETWEEN 250 AND 900 MeV SELECTED FROM COSMIC RADIATION.
M.Bercovitch, H.Carmichael, G.C.Hanna and E.P.Hincks.
Phys. Rev., Vol. 119, No. 1, 412-31 (July 1, 1960).

The production of low-energy neutrons in U, Pb, W, and Sn by protons of six selected energies between 250 and 900 MeV was measured using cosmic radiation as a proton source. The protons were selected and their energy measured by a vertical counter telescope containing three Cherenkov detectors which employed liquid nitrogen, water, and Plexiglas as radiating media. The protons interacted in 22 and 44 g cm^{-2} thick slabs of the target elements, and the neutrons produced were detected in a 4 ft cubic paraffin moderator, $B^{10}F_3$ counter assembly placed below the proton selecting

lescope. The principal body of the data was obtained at 3260 m
titude; a series of runs at 150 m was made to check the high-alti-
de data for muon contamination of the selected protons. The pro-
n-gated neutron rates for the various targets were converted to
ean neutron multiplicities per interaction using (a) the efficiency
the neutron detector as measured using calibrated Pu^{240} spontane-
ıs fission and Ra-α-Be neutron sources, and (b) the interaction
ross-sections of Chen, Leavitt, and Shapiro. The mean multiplici-
es per interaction range from 5.8 ± 1.0 for 300 MeV protons on
g cm^{-2} thick Sn, to 26.7 ± 4.2 for 820 MeV protons on 44 g cm^{-2}
ick U. The multiplicities predicted from the Monte Carlo nucleon
ıscade calculation of Metropolis et al. (Abstr. 654-5 of 1959) and
e Monte Carlo evaporation calculation of Dostrovsky et al. (Abstr.
384 of 1959) are in agreement with the measurements when second-
y neutron production in the thick targets is taken into account.

537.59 : 539.1.07

APPLICATIONS OF NUCLEAR EMULSIONS IN THE STUDY OF
HE COSMIC RADIATION. See Abstr. 12797

537.59 : 539.1.07

THE EXPOSURE OF EMULSIONS IN FREE SPACE.
ee Abstr. 12796

NUCLEUS

539.14

13099 THE ATOMIC NUCLEUS.
R.E.Peierls.
ci. American, Vol. 200, No. 1, 75-80, 82 (Jan., 1959).

A review of the information on nuclear forces to be gained by
eating the nucleus from the viewpoints of the liquid-drop, the
hell, and the optical models.

539.14

13100 THE STATISTICAL THEORY OF THE NUCLEUS. IV.
P.Gombás, P.Szépfalusy and E.Mágori.
cta phys. Hungar., Vol. 7, No. 2, 251-4 (1957). In German.

For Pt III, see Abstr. 8148 of 1955. This is a continuation of
arlier work in which a scalar Yukawa interaction was used with
arious shapes for the density distribution, to minimize the binding
nergy of the nucleus. The present work discusses the effects of
arying the range of the interaction. A slight improvement for the
inding energy per particle and equilibrium Z for fixed A is obtained.
J.A.Evans

539.14

13101 ENERGY GAP IN NUCLEAR MATTER.
V.J.Emery and A.M.Sessler.
hys. Rev., Vol. 119, No. 1, 248-51 (July 1, 1960).

The magnitude of the energy gap in nuclear matter associated
ith a highly correlated ground state of the type believed to be im-
ortant in the theory of superconductivity has been evaluated theoreti-
ally. The integral equation of Cooper, Mills, and Sessler (Abstr.
2187 of 1959) is linearized and transformed into a form suitable for
umerical solution. The energy gap, calculated by using an appro-
riate single-particle potential and the Gammel—Thaler two-body
otential, is found to be a very strong function of the density of
uclear matter, and of the effective mass at the Fermi surface. It
s concluded that the magnitude of the energy gap for nuclear matter
hould not be compared directly with experimental values for finite
uclei, although the results suggest that if the theory is extended to
pply to finite nuclei it probably would be in agreement with experi-
ent.

539.14 : 539.11

PERTURBATION THEORY APPLIED TO NUCLEAR MATTER.
ee Abstr. 12886

539.14

13102 DEPENDENCE OF THE INTERNAL NUCLEAR POTENTIAL PARAMETERS ON THE PARTICLE
UMBER. M.Ya. Amus'ya.
h. eksper. teor. Fiz., Vol. 38, No. 3, 834-42 (March, 1960). In
ussian.

The dependence of the oscillator potential parameters on the
umber of nucleons is determined on the assumption that the mean
nergy per nucleon in the nucleus is constant. The possible influence
f three-particle interaction is considered.

539.14

13103 SHELL MODEL CALCULATIONS IN THE LEAD REGION WITH A DIFFUSE NUCLEAR POTENTIAL.
J.Blomqvist and S.Wahlborn.
Ark. Fys., Vol. 16, Paper 46, 545-66 (1960).

With the use of a diffuse potential of the Woods—Saxon type, including a spin-orbit interaction, numerical solution of the single nucleon Schrödinger equation is performed, with values of the potential parameters appropriate to the lead region. Single particle energies and radial wave functions are obtained for the orbitals in the major shells adjacent to Z = 82 and N = 126, and the changes of the energy eigenvalues with the parameters are estimated. Pairing energy corrections are introduced. The possible occurrence of quadrupole oscillation states is considered, and the corresponding collective corrections to the single particle states are applied. The perturbed energies are compared with the level schemes of the four nuclei, which differ from the double-magic Pb^{208} with one nucleon, and some suggestions and predictions are made.

539.14

13104 CONCERNING FOUR-FOLD CORRELATIONS IN LIGHT NUCLEI. V.G.Solov'ev.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 2, 286-9 (March 11, 1960).
In Russian.

A study, on the basis of the shell model, is made of interactions of nucleons, in the outer shells of light nuclei, leading to the formation of four-fold correlations of nucleons of the α-particle type; and hence certain regularities in the binding energies of last neutrons are explained. It is shown that four-fold correlations vanish for $A > 40$ when the number of neutrons exceeds that of protons in stable nuclei.
E.A.Sanderson

539.14

13105 ON THE COLLECTIVE MODE OF INTERNAL MOTION OF THE NUCLEUS TO BE COUPLED WITH THE IRROTATIONAL SURFACE MOTION.
S.Nagata, R.Tamagaki, S.Amai and T.Marumori.
Progr. theor. Phys., Vol. 19, No. 5, 495-516 (May, 1958).

From analyses of unsatisfactory points in the usual irrotational collective model, it is considered that there should exist a kind of "internal" rotational collective motion to be coupled with the usual irrotational surface motion. Using Watanabe's method (Abstr. 5888 of 1957) a generalization of the collective description with redundant variables is developed and it is shown that the introduction of the rotational collective motion is indispensable in describing the collective motion in a closed form consistently. It is confirmed that this rotational mode plays an important role in explaining the discrepancy between the experimental and theoretical values of the effective moments of inertia of nuclei. The fundamental assumption of the various models concerning the moments of inertia is discussed.

539.14

13106 RIGIDITY FOR OCTUPOLE TYPE SURFACE DEFORMATION AND SHELL STRUCTURE.
S.Suekane and W.Watari.
Progr. theor. Phys., Vol. 20, No. 1, 108-10 (July, 1958).

The surface rigidities C_3 of closed shells for an octupole type of surface deformation are calculated using a method similar to that of Marumori, Suekane and Yamamoto (Abstr. 6430 of 1957). In the regions between closed shells the calculated values of C_3 are very small, suggesting that the corresponding nuclei are susceptible to octupole type deformations. This is in fairly good agreement with the trend of experimental evidence.
E.A.Sanderson

539.14 : 539.17

13107 NONLOCAL OPTICAL MODEL FOR NUCLEON—NUCLEAR INTERACTIONS.
P.K.Wyatt, J.G.Wills and A.E.S.Green.
Phys. Rev., Vol. 119, No. 3, 1031-42 (Aug. 1, 1960).

An attempt is made to achieve a unified potential description of the gross structure of the nucleon—nuclear interactions in bound states and in states of scattering. A model is employed with a nonlocal complex diffuse potential with spin—orbit coupling and surface absorption. This represents a relatively simple nonlocal generalization of the usual static models which might reasonably be expected to describe the nucleon—nuclear interaction in the low-energy range (say from −25 to 25 MeV). Choosing the range of nonlocal forces as suggested by considerations of the properties of infinite nuclear matter, the real parameters are fixed largely on the basis of neutron and proton separation energies. Two absorption parameters are then adjusted to provide agreement with total, reaction and differential elastic cross-section data for neutrons. It is found that the success of local optical models with energy-dependent parameters are largely preserved. Contrary to expectations, it is found that non-locality tends to accentuate rather than wash out diffraction patterns. Although a diverse variety of experimental phenomena are treated, a range of parameter choices remains. Because of theoretical uncertainties as to the size of the "rearrangement energy", an effort is made to establish limits as to its magnitude on phenomenological grounds. The influence of several choices upon the physical phenomena used in adjusting the parameters of this model are shown. It would appear that this study does allow for a rearrangement energy but that it is rather small (<6 MeV) and comparable to the probable fluctuations of the potential from element to element.

539.14

13108 SINGLE-PARTICLE STATES IN DEFORMED NON-LOCAL DIFFUSE BOUNDARY POTENTIALS.

R.H.Lemmer and A.E.S.Green.
Phys. Rev., Vol. 119, Vol. 119, No. 3, 1043-52 (Aug. 1, 1960).

Using the spherical wave-functions generated in a previous investigation (see preceding abstract), the influence of spheroidal deformation is examined with the aid of perturbation theory. The combined calculations yield the energies of single-particle states for a diffuse boundary, nonlocal deformed potential. Specific calculations are performed for light nuclei around A = 25 and in the rare-earth region between A = 150 and A = 180. An analysis of nuclear ground-state spins and magnetic moments is presented in terms of the computed level schemes and wave-functions. The results confirm the general aspects of the Nilsson, Mottelson results as obtained with adjusted harmonic oscillator potentials, although some differences arise in detail. In particular, the calculated coefficients usually show less mixing of different angular momentum states in the present case. The fact that the unperturbed potentials used in this calculation were obtained from completely independent theoretical and experimental considerations is satisfying and further tends to confirm that the phenomenological model has a strong basis in reality. A discussion of the relationship of the phenomenological model to the self-consistent nuclear model of Brueckner is given.

539.14

13109 REMARKS ON THE OPTICAL MODEL OF THE NUCLEUS. V.G.Grishin and M.I.Podgoretskii.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1593-4 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1132-3 (Nov., 1959).

The scattering amplitude, $f_{\text{opt}}(\theta)$, as given by the optical model is compared with a more exact formula, which is derived for a distribution of identical and independent scatterers. It is found that $f_{\text{opt}}(\theta)$ should be multiplied by a factor $f_0(\theta)/f_0(0)$, where $f_0(\theta)$ is the scattering amplitude for a free single centre. The correction is found to be a few percent for π meson- and nucleon-scattering by nuclei. E.A.Sanderson

539.14 : 539.17

PROTON POLARIZATION AS A TEST OF THE LOW ENERGY OPTICAL MODEL. See Abstr. 11401

539.14

13110 ON SUPERFLUIDITY OF LIGHT NUCLEI.

V.B.Belyaev, B.N.Zakhar'ev and V.G.Solov'ev.
Zh. eksper. teor.Fiz., Vol. 38, No. 3, 952-4 (March, 1960).
In Russian.

The physical ideas and mathematical methods developed in superconductivity theory can be used to study properties of light nuclei. The shell model of the nucleus is used to show that allowance for residual interactions of protons and neutrons located near the Fermi surface energy leads to appearance of superfluid states. Data on the binding energies of the last neutron in the $22 \leq A \leq 32$ region indicate the presence of paired (pp)-, (nn)- and (np)-correlations with the same quantum numbers s and m, which are related to superfluidity of the light nuclei.

539.14

13111 TENSOR FORCE EFFECTS IN ODD—ODD SPHERICAL NUCLEI. N.D.Newby,Jr.

Phys. Rev., Vol. 119, No. 2, 747-8 (July 15, 1960).

A study of the ground-state coupling rules in odd—odd spherical nuclei reveals that in almost all cases where Nordheim's weak rule is applicable both particles have spin and orbital angular momentum parallel rather than antiparallel. A semiclassical model is employed to indicate that an attractive n—p tensor force will tend to break down Nordheim's weak rule. Examination of the quantum-mechanical formula substantiates this finding.

539.14

13112 STRUCTURE OF THE Be^9 NUCLEUS.

I.Sh.Vashakidze, T.I.Kopaleishvili, V.I.Mamasakhlisov and G.A.Chilashvili.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 937-41 (March, 1960). In Russian.

For the Be^9 nucleus, viewed as consisting of two α-particles an a neutron, the equilibrium distances between the α-particles and between the neutron and centres of the α-particles were determined from the condition of minimum energy. Vibrations along the symmetry axis and about the centre of mass of the α-particles were considered and the energy levels of the Be^9 nucleus were derived. The results obtained were compared with the data on the ${}_{\Lambda}Be^9$ hypernucleus.

539.14

13113 THEORETICAL PREDICTIONS FOR THE SPECTRA OF THE ODD-MASS XENON AND TELLURIUM ISOTOPES.

N.K.Glendenning.
Phys. Rev., Vol. 119, No. 1, 213-17 (July 1, 1960).

The spectra of the isotopes $Te^{123,125}$, $Xe^{127,129}$ are calculated by assuming that the odd neutron, having available the $3s_{1/2}$ and $2d_{3/2}$ states, is coupled to collective surface vibrations of the core. Good agreement is obtained with the known levels in these nuclei using a reasonable value for the coupling parameter. To obtain the agreement, the $d_{3/2}—s_{1/2}$ splitting, ϵ, must be regarded as a function of neutron number. The manner in which ϵ varies, as found in the intermediate coupling calculation is compared with the predictions of the pairing correlation theory originally introduced in connection with superconductivity. Agreement as to the general trend is found. This may be regarded to some extent as an indication of the applicability of the pairing correlation theory to nuclear structure calculations.

539.14

13114 GAMMA—GAMMA DIRECTIONAL CORRELATION IN ${}^{200}Hg$. Z.Grabowski and B.van Nooijen.

Ark. Fys., Vol. 16, Paper 41, 479-80 (1960).

The spin of the 1885 keV level in Hg^{200} was determined by a directional correlation measurement. Using internal conversion data, it is possible to make the following assignments: 4^- to the 1885 keV level, 2^+ to the 1595 keV level and 3^- to the 2137 keV level

539.14

13115 NUCLEAR POLARIZATION OF WEAKLY-MAGNETIC ELEMENTS INTRODUCED INTO A FERROMAGNETIC.

B.N.Samoilov, V.V.Sklyarevskii and E.P.Stepanov.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1944-6 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1383-4 (Dec., 1959).

Experiments were carried out on dilute alloys of antimony, indium and chromium with iron to measure, at helium temperatures the anisotropy of (a) the 566 keV γ-rays emitted after the β-decay of Sb^{122}, (b) the 192 keV γ-rays from In^{114m}, and (c) the 320 keV γ-rays emitted by Cr^{51}, after K-capture. From the results approximate values of 25% and 30% for the polarization and 1.9×10^6 and 1.5×10^6 Oe for the effective magnetic field at the nucleus, were calculated for Sb^{122} and In^{114m} respectively. No anisotropy was observed for Cr^{51} (in Cr—Fe alloys) to within an accuracy of not les than 0.5%. E.A.Sanderson

539.14

13116 ORIENTATION OF NUCLEI DURING SATURATION OF FORBIDDEN RESONANCE AND DOUBLE RESONANCE.

G.R.Khutsishvili.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 942-7 (March, 1960).
In Russian.

The parameters f_k characterizing the degree of orientation of nuclei were computed in the case of forbidden paramagnetic resonance and double resonance (Abstr. 7617 of 1956; 6453 of 1957). Modifications of the double resonance method were examined.

539.1

13117 ESTIMATION OF THE NUCLEAR MOMENT OF INERTI AND THE g_R-FACTOR.

Tseng Chin-Yuen, Chang Ching-Ying and Yang Li-Ming.
Scientia Sinica, Vol. 9, No. 1, 68-78 (Jan., 1960).

A detailed estimation of the nuclear moment of inertia and the lective g_R factor based on the cranking model of Inglis and son's wave function is made. The agreement with the experimental ue is satisfactory not only in regard to magnitude but also in the dency of variation with A and with excited internal configurations. e reason for this success probably lies in the proper choice of axial-symmetric self-consistent field including a strong spin-orbit ipling.

539.14

13118 MOMENTS OF INERTIA OF ODD ATOMIC NUCLEI.

Yu.T.Grin', S.I.Drozdov and D.F.Zaretskii.
. eksper. teor. Fiz., Vol. 38, No. 4, 1297-1303 (April, 1960).
Russian.

An expression is derived for the moment of inertia of odd nuclei, effect of pair correlation being taken into account. The theory is mpared with experiments.

539.14

13119 ROTATIONAL ENERGY AND MOMENTS OF INERTIA OF NONAXIAL NUCLEI.

;.Davydov, N.S.Rabotnov and A.A.Chaban.
. eksper. teor. Fiz., Vol. 38, No. 4, 1311-15 (April, 1960).
Russian.

It is shown that the dependence of the ratio of rotational energies a nonaxial nucleus on the ratio of the energy of two rotational spin-states changes insignificantly when the nuclear moments of inertia viate from their hydrodynamical values.

539.14

13120 HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF 17 HR BROMINE-76.

Lipworth, T.M.Green, H.L.Garvin and W.A.Nierenberg.
ıys. Rev., Vol. 119, No. 3, 1053-60 (Aug. 1, 1960).

The nuclear spin, the nuclear magnetic-dipole interaction nstant a, and the nuclear electric-quadrupole interaction constant were determined for 17 hr Br^{76} by an atomic-beam experiment. ıe results are: $I = 1$, $|a| = 345.422 \pm 0.014$ Mc/s, $| = 314.329 \pm 0.022$ Mc/s, $b/a = 0.9100 \pm 0.0001$. The nuclear agnetic-dipole and electric-quadrupole moments are calculated be, respectively, $\mu = \pm 0.5479 \pm 0.001$ nuclear magneton, and $= \mp 0.27 \pm 0.01$ barn. The sign of μ, though not determined, is obably negative. The hyperfine structure separations are $\nu(\frac{5}{2}, \frac{3}{2}) = 1256.47 \pm 0.05$ Mc/s and $\Delta\nu(\frac{1}{2}, \frac{3}{2}) = 189.11 \pm 0.05$ Mc/s. ıe hyperfine structure is of particular interest because the $F = \frac{1}{2}$ d $\frac{3}{2}$ levels are inverted and not in normal order. This inversion the first case of its kind established in an atomic-beam experi-ent.

539.14 : 539.18

13121 MEASUREMENT OF THE HYPERFINE STRUCTURE SPLITTING OF THE $^4F_{9/2}$ GROUND STATE IN THE ^{59} I SPECTRUM AND DETERMINATION OF THE QUADRUPOLE OMENT OF THE Co^{59} NUCLEUS.

v.Ehrenstein, H.Kopfermann and S.Penselin.
Phys., Vol. 159, No. 2, 230-1 (1960). In German.

The hyperfine structure splittings of the electronic ground state a^4Fe in the Co^{59} I spectrum were measured with a magnetic omic-beam resonance-apparatus. From these splittings, the mag-tic dipole and electric quadrupole interaction constants found to be $a^4F_{9/2}) = (450\,284 \pm 0.01)$ Mc/s, $B(a^4F_{9/2}) = (139\,63 \pm 0.5)$ Mc/s. king into account the mixture of the $a^4F_{9/2}$ state with states of the me $3d^4\,4s^2$ electron configuration, an electric quadrupole moment Co^{59} of $Q = (0.404 \pm 0.04) \times 10^{-24}$ cm^2 was obtained. No Stern-imer correction has been included.

539.14

13122 ON THE EXCHANGE MAGNETIC MOMENTS.

E.Kuroboshi and Y.Hara.
rogr. theor. Phys., Vol. 20, No. 2, 163-70 (Aug., 1958).

The exchange magnetic moment operators for the two-nucleon stem are obtained in terms of photopion production matrix ele-ents. This photopion production part is closely related to the on—nucleon scattering part, thus enabling one to use π—N scat-ring experimental values in the expressions of the exchange mag-tic moment operators. These formulae are applied to the case triton magnetic moment and those of heavy nuclei (the Fermi gas odel). In the former case, quite a good result is obtained, while the latter it is found that exchange magnetic moments can explain ıly small parts of the deviations from the Schmidt lines.

539.14

13123 NUCLEAR MOMENTS OF THE ODD ISOTOPES OF GADOLINIUM.

N.I.Kaliteevskii, M.P.Chaika, I.Kh.Pacheva and É.E.Fradkin.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 882-4, (Sept., 1959).
In Russian. English translation in: Soviet Physics-JETP (New York), Vol. 37(10), No. 3, 629-30 (March, 1960).

The hyperfine structure of three lines in the spectrum of gadolinium of wavelength 5015, 5103, and 5251 A, was studied using a photoelectric spectrometer with a Fabry—Perot interferometer. Separated isotopes of Gd^{155} and Gd^{157} were used. The results confirm those of paramagnetic-resonance experiments and show that the spin of both isotopes is $I = 3/2$. The ratio of the magnetic moments μ_{155}/μ_{157} was shown to be 0.79 ± 0.02, the absolute values being $\mu_{155} = -0.32 \pm 0.04$ and $\mu_{157} = -0.40 \pm 0.04$. For the quadrupole moments, the ratio $Q_{155}/Q_{157} = 0.78 \pm 0.06$ was obtained and also the absolute values $Q_{155} = 1.6 \times 10^{-24}\,\text{cm}^2$ and $Q_{157} = 2 \times 10^{-24}\,\text{cm}^2$. The values of the internal quadrupole moments Q_0 were calculated from this data, together with the distortion parameters δ. The results were as follows:

$$Q_{O155} = 8 \times 10^{-24}\,\text{cm}^2, \qquad Q_{O157} = 10 \times 10^{-24}\,\text{cm}^2,$$
$$\delta_{155} = 0.31, \qquad \delta_{157} = 0.37.$$

The results are in good agreement with those of Coulomb excitation measurements. On the basis of Nilsson's scheme, the values of g_K and g_R, the gyromagnetic ratios for the internal and collective motions were calculated. The values obtained were $g_{K_{155}} = -0.8$, $g_{K_{157}} = -0.9$ and $g_{R_{155}} = g_{R_{157}} = 0.7$ nuclear magnetons. These results are compared with the calculations of Gauvin (Abstr. 1710 of 1959). R.E.Meads

539.14

13124 THE EQUILIBRIUM SHAPE OF ATOMIC NUCLEI.

G.F.Filippov.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1316-19 (April, 1960).
In Russian.

The equilibrium shape of atomic nuclei was found for the case when the deformations are small and the external nucleons do not interact.

539.14 : 534.8

13125 THE PROFILE OF THE NUCLEAR ACOUSTIC RESONANCE LINE.

N.G.Koloskova and U.Kh.Kopvillem.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1351-3 (April, 1960).
In Russian.

According to the first author's theory of the interaction of ultrasonic waves with the nuclear spin-systems in cubic crystals, the prevailing theory, based on the concept of nuclear magnetic resonance, is erroneous. The profile of the nuclear acoustic resonance absorption line is represented by a quantity $A(\omega)$, which is given for the case of a continuous progressive acoustic wave, travelling along the [110] axis of a cubic crystal, placed in a strong constant magnetic field. Theoretical values of the line widths at half-intensities are calculated for certain cases, and compared with experimental values. A short paragraph considers the effect of a single ultrasonic impulse. N.Davy

539.14

13126 ULTRA-HIGH RESOLUTION γ-RAY RESONANCE IN ZINC-67.

D.E.Nagle, P.P.Craig and W.E.Keller.
Nature (London), Vol. 186, 707-8 (May 28, 1960).

Mössbauer resonance absorption was observed of the 93 keV γ-ray from the 9.4 μsec first excited state of Zn^{67}. The ratio of natural line-width to γ-ray energy is in this case $1/10^{15}$ and is 10^3 narrower than in Fe^{57}. An annealed source of Ga^{67} produced by deuteron irradiation of zinc oxide was mounted close to a zinc oxide absorber in a liquid helium cryostat. Observations were made of the magnetic field required to be applied to the absorber to destroy the resonance condition by nuclear Zeeman effect. With an applied field of 500 G the absorber transmission of the 93 keV γ-ray increased by (0.240 ± 0.025)%. No resonance absorption effect was observed at room temperature or at low temperature using an unannealed zinc oxide—alumina absorber, in which it might be expected that the active Ga atoms would be displaced from their proper lattice positions. R.E.Meads

539.14

13127 NUCLEAR GIANT DIPOLE RESONANCE.

K.A.Brueckner and R.Thieberger.
Phys. Rev. Letters, Vol. 4, No. 9, 466-8 (May 1, 1960).

The relationship between the classical and independent-particle descriptions of the dipole resonance is clarified. It is shown that in nuclear matter the single-particle energies generally depend on the fluctuations in the neutron—proton density, the eigenvalue being raised by about 15% above the usual single-particle value.

A.M.Green

539.14

13128 ZEEMAN EFFECT IN THE RECOILLESS γ-RAY RESONANCE OF Zn^{67}.

P.P.Craig, D.E.Nagle and D.R.F.Cochran.

Phys. Rev. Letters, Vol. 4, No. 11, 561-4 (June 1, 1960).

A detailed description is given of measurements carried out on the influence of the nuclear Zeeman effect and other perturbations upon the Mössbauer effect in Zn^{67} embedded in an enriched ZnO lattice. A tentative discussion is made of the factors which possibly contribute to the features of the resonance curve obtained.

E.A.Sanderson

539.14 : 539.17

13129 STRUCTURE OF THE GIANT RESONANCE IN PHOTONUCLEAR REACTIONS. E.V.Inopin.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 992-4 (March, 1960). In Russian.

Triply-peaked photonuclear cross-sections are discussed as evidence for the existence of non-axially symmetric nuclei. Using a variational principle, an approximate expression was obtained for the resonance energies in terms of the three principal axes of the nucleus. The deformation parameters for Tb^{159} were deduced from experimental data; they are consistent with data on neighbouring nuclei, based on independent considerations. D.W.L.Sprung

539.14

13130 THE MÖSSBAUER RADIATION.

W.E.Kock.

Science, Vol. 131, 1588-90 (May 27, 1960).

Survey article.

539.14 : 539.2

RECOILLESS RAYLEIGH SCATTERING IN SOLIDS: STUDY USING THE MOSSBAUER EFFECT. See Abstr. 11560

539.14 : 539.2

MOSSBAUER EFFECT FOR Fe^{57} IN Fe_2O_3: EFFECT OF CHEMICAL BINDING. See Abstr. 11561

539.14 : 539.2 : 538.2

MEASUREMENT OF LOCAL MAGNETIC FIELDS AT IMPURITY Fe^{57} NUCLEI IN Fe, Co, Ni, AND n-TYPE Si, USING THE MÖSSBAUER EFFECT. See Abstr. 11826

539.14 : 539.2 : 538.2

DIRECTION OF THE EFFECTIVE MAGNETIC FIELD AT THE NUCLEUS IN FERROMAGNETIC IRON: DETERMINATION USING THE MÖSSBAUER EFFECT. See Abstr. 11827

539.14

13131 EFFECTS OF CHEMICAL BINDING ON NUCLEAR RECOIL. M.S.Nelkin and D.E.Parks.

Phys. Rev., Vol. 119, No. 3, 1060-8 (Aug. 1, 1960).

The recoil of a chemically bound nucleus is considered for slow-neutron scattering and for the resonant absorption of neutrons or gamma rays. The Doppler-broadened resonance line shape is derived in terms of the time-dependent self-correlation function describing the motion of a nucleus due to the interatomic forces. This explicitly relates the resonance line shape to the differential scattering cross-section for slow neutrons in the Fermi pseudopotential approximation. Within this formulation an expansion for large nuclear recoil is naturally suggested. For the case of a crystal, this expansion can be directly related to the expansion associated with the central limit theorem of probability theory and can therefore be proved to be asymptotic in nature. The expansion parameter is $(K_{av}/R)^{1/2}$, where K_{av} is the average kinetic energy of a nucleus and R is the recoil energy for a free nucleus at rest. The leading term of the expansion is the weak binding limit originally obtained by Lamb. In this limit the Doppler-broadened line shape is the same as would obtain for an ideal monatomic gas of the same mass with an effective temperature $T' = (\frac{2}{3}) K_{av}$. For noncrystalline systems, a similar expansion with the same leading term can be obtained by a rearrangement of the terms in an expansion used by Wick (Abstr. 7778 of 1954) to study the slow-neutron total cross-section. The relation of the present expansion to Wick's expansion is discussed.

539.1

13132 AXIAL SYMMETRY OF ATOMIC NUCLEI.

D.A.Zaikin.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1570-1 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New Yo Vol. 36(9), No. 5, 1114-15 (Nov., 1959).

A perturbation method is used to find the energy levels, of s, p, d and f state nucleons in an infinite ellipsoidal square well, as functions of the deformation parameters, up to and including quadratic terms. The calculations show, within the limitations of the method, that for a few (≥ 3) particles above a closed shell the ener minimum can correspond to an axially non-symmetric shape of the nucleus.

E.A.Sanderso

539.1

13133 ON THE LEVEL STRUCTURE OF B^{10}

J. Kantele.

Ann. Acad. Sci. Fennicae A VI, No. 37, 29 pp. (1959).

Evidence for a new energy level at 7.42 MeV excitation energy in B^{10} was found. The half-width of this level is about 100 keV, the corresponding $Be^9(p,\gamma)B^{10}$ resonance energy being 930 ± 15 keV. The peaking of the (p,d) and (p,α) reactions at the same energy, found by other investigators, is explained in terms of the aforementioned level, and these modes of dissociation are assumed to suggest that the level is an isobaric spin T = 0 state. Observed radiative transitions to the 0.72, 1.74 and 2.15 MeV levels, togethe with the particle decay of the 7.42 MeV state, seem to lead to the spin and parity assignments 1+ or 1÷ for the level, the former bein more probable. The existence of the 7.47 MeV state was demonstr ted and the width of this level is measured to be about 35 keV. Thi level is seen to decay to the ground level and to the 0.72 and 2.15 MeV levels. Some further γ-rays were observed and explaine in terms of energy differences between different levels in B^{10}. A decay scheme for the 7.48, 7.47 and 7.42 MeV levels is proposed and discussed.

539.1

13134 ODD—EVEN DEPENDENCE OF NUCLEAR LEVEL DENSITY PARAMETERS. R.E.Bullock and R.G.Moore,

Phys. Rev., Vol. 119, No. 2, 721-31 (July 15, 1960).

Previously reported experimental (n,p) and (n,α) cross-sectio data are analysed to determine nuclear level density parameters f the Fermi gas model which best fit the experimental data for targe nuclei ranging in mass number from 9 to 64. Level density parameters for odd—odd and even—even nuclei are obtained in terms o those for the better-known odd-A values. The results of this analysis are

$$\tfrac{1}{2}C(\text{odd—odd}) = C(\text{odd-A}) = 5C(\text{even—even}).$$

Brief mention is made of the direct-interaction contribution in (n,p reactions. Experimental measurements which would be most bene ficial for further theoretical analysis are suggested.

539.1

13135 ORDER OF LEVELS IN THE SHELL MODEL AND SPIN OF Be^{11}. I.Talmi and I.Unna.

Phys. Rev. Letters, Vol. 4, No. 9, 469-70 (May 1, 1960).

By extrapolating linearly from the data of B^{12} and C^{13}, it is sh that the $\frac{1}{2}^+$ spin of Be^{11} could be due to the last neutron being in a $2s_{1/2}$ level. This level is predicted to be 0.21 MeV below the $1p_{1/2}$ level, contrary to the standard order of levels in the shell model.

A.M.Gree

539.

13136 ROTATIONAL LEVELS OF Li^7.

V.I.Mamasakhlisov and T.I.Kopaleishvili.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1134-6 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York) Vol. 37(10), No. 4, 807-8 (April, 1960).

It is shown that certain levels of Li^7 can be interpreted as hav rotational character if the α—triton model is assumed to apply to t nucleus.

S.J.St-Lors

539.

13137 CALCULATION OF ENERGY LEVELS OF Tl^{206} AND Bi^{210} NUCLEI. L.A.Sliv and Yu.I.Kharitonov.

Zh. eksper. teor. Fiz., Vol. 137, No. 4(10), 1151-3 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 819-20 (April, 1960).

Using available data on neighbouring nuclei, the energy levels of Tl^{206} and Bi^{210} were determined. Two alternative level schemes are proposed for Bi^{210} which depend upon the nature of the ground g either 0⁻ or 1⁻. Measurements are suggested which would ve useful in further interpretation of these proposed level emes.

R.H.Thomas

539.14

3138 NUCLEAR BINDING ENERGIES AND LOW-LYING ENERGY LEVELS IN THE $2s_{1/2}$ AND $1d_{3/2}$ SHELLS.

rima.

gr. theor. Phys., Vol. 19, No. 4, 421-50 (April, 1958).

On the basis of the j-j coupling shell model, the nuclear energies he $2s_{1/2}$ and $1d_{3/2}$ shells are given by linear combinations of the ameters expressing the nuclear and Coulomb interaction energies wo-nucleon states, the single-nucleon energies in $2s_{1/2}$ and $1d_{3/2}$ lls and the Coulomb interaction energies of a single proton in $_2$ and $1d_{3/2}$ shells with the closed shells. The best values of these ameters are determined by a least-squares fit to the experimental ling energy data. The mean deviations are very small, and this ws the adequacy of the shell model in the ground states of these lei. By using these values of parameters the excitation energies calculated, and it is shown that in some excited states configura- interactions seem to be important. The two-body force required ive the best fit with the interaction energies in two-nucleon states iscussed.

539.14 : 539.16

13139 PARTIAL GAMMA RAY WIDTHS FOR LOW LYING LEVELS IN ALUMINIUM AND MAGNESIUM.

.Metzger, C.P.Swann and V.K.Rasmussen.

clear Phys., Vol. 16, No. 4, 568-90 (June (1), 1960).

The gamma-rays resulting from the bombardment of Al and Mg protons of 3.3 to 4.2 MeV energy were used to excite low-lying els in Al^{27}, Mg^{24}, and Mg^{25}. Combining the results of self-absorp- and resonance-scattering studies with measured branching ratios, following partial widths Γ_0 for the ground-state transitions were ained:

$$(1.01\ \text{MeV}, \tfrac{3}{2}+)\ \text{level in}\ Al^{27} : \Gamma_0 = 0.98\ \Gamma = (3.9 \pm 1.6) \times 10^{-4}\ \text{eV}$$

$$2.21\ \text{MeV level in}\ Al^{27} : \Gamma_0 = 0.98\ \Gamma = (g_1/g_2)(2.4 \pm 0.3) \times 10^{-2}\ \text{eV}$$

$$(1.37\ \text{MeV}, 2+)\ \text{level in}\ Mg^{24} : \Gamma_0 = \Gamma = (4.2 \pm 1.5) \times 10^{-4}\ \text{eV}$$

$$(1.61\ \text{MeV}, \tfrac{7}{2}+)\ \text{level in}\ Mg^{25} : \Gamma_0 = \Gamma = (3.0 \pm 1.5) \times 10^{-2}\ \text{eV}.$$

angular distribution of the 1.01 MeV resonance radiation was nd to be of the form $W(\theta) = 1 + (0.02 \pm 0.13)\ P_2(\cos\theta)$, that of the 1 MeV radiation $W(\theta) = 1 + (0.23 \pm 0.03)\ P_2(\cos\theta)$.

539.14 : 539.17

13140 STUDIES OF LOW-LYING LEVELS OF EVEN—EVEN NUCLEI WITH (d,p) AND (d,t) REACTIONS.

.Cohen and R.E.Price.

ys. Rev., Vol. 118, No. 6, 1582-90 (June 15, 1960).

Low-lying states of even—even nuclei in the vibrational region e studied by exciting them with (d,p) and (d,t) reactions. The ative cross-sections for exciting ground states (G) bear little ationship to whether they are allowed or forbidden by the simple yer—Jensen configurations, so that configuration mixing is gener- large. Some of the details of this mixing are obtained. The owed portion of these cross-sections are generally quite close to single-particle values. First and second excited states are much re strongly excited than expected theoretically. In Pd^{104}, Pd^{106}, ^{4}, and Pt^{196} searches for the triplet in second excited states in- ate that its total spacing must be less than 80 keV. New states re found in the triplet region of Cd^{114} and Cd^{112} bringing the total nber of known states in these to 5 and 4, respectively; each includes 0^+ and two 2^+ states. Higher excited states were studied and in ost all cases they occur below the expected position of the third mber of the vibrational band; this gives evidence on the size of the rgy gap. The location of all 0^+ levels up to 3 MeV is determined several nuclei. In two cases the 3^+ states required by Davidov— pov theory are found to be 0^+, and in other cases they are not nd at all. A number of previously unknown levels are catalogued.

539.14 : 539.17

3141 ENERGY LEVELS OF THE SILICON ISOTOPES FROM INELASTIC PROTON SCATTERING. R.E.White.

s. Rev., Vol. 119, No. 2, 767-71 (July 15, 1960).

Energy levels of the stable isotopes Si^{28}, Si^{29}, and Si^{30}, up to 6.5 MeV excitation were investigated by studying the inelastic scattering of 7.5 to 8.5 MeV protons from a thin silicon dioxide target with a broad-range magnetic spectrograph. Several new levels are reported, and the significance of the Si^{28} results is discussed in regard to a previously proposed interpretation of the level spectrum.

539.14 : 539.16

13142 THE ODD A AND ODD Z NUCLEI IN THE REGION OF A = 190. L.Feuvrais.

Ann. Phys. (Paris), Ser. 3, Vol. 5, No. 1-2 181-224 (Jan. - Feb., 1960). In French.

The energy levels of three nuclei in the region of A = 190, Os^{191}, Os^{193}, and Hg^{197}, were studied. A magnetic-lens spectrometer was used and β-γ coincidence techniques. A study of the γ-ray spectra and of the conversion electrons was made. The level schemes are discussed in terms of the collective model.

L.L.Green

539.14

13143 RESONANCE SCATTERING OF γ-QUANTA ON Se^{76} NUCLEI. N.N.Delyagin.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1111-14 (April, 1960). In Russian.

The lifetime of the first excited state of Se^{76} (0.56 MeV energy) was measured by the method of resonance scattering of γ-quanta, employing a gaseous As^{76} source in the form of AsH_3. The value $(1.3 \pm 0.2) \times 10^{-11}$ sec was obtained for the lifetime. The absence of resonance scattering of 1.21 MeV γ-quanta corresponding to the transition from the second excited state of Se^{76} to the ground state indicates that the corresponding partial lifetime of the second excited state in Se^{76} is longer than 6×10^{-12} sec.

539.14 : 539.16

13144 DETERMINATION OF THE CONFIGURATION MIXING IN RaE FROM THE β^--DECAYS $Pb^{210} \rightarrow Bi^{210} \rightarrow Po^{210}$

P.Banerjee and H.D.Zeh.

Z. Phys., Vol. 159, No. 2, 170-7 (1960). In German.

From the anomalies in the β-decays of Pb^{210} and Bi^{210}, relations between the shell-model wave-functions of the ground states of Pb^{210}, Bi^{210} and Po^{210} are derived. These relations are, however, not satisfied by wave-functions calculated under the assumption of two-body central forces of zero range. Use is made of the fact that such forces seem to be a good approximation for even—even nuclei (in the present case Pb and Po), but not for odd—odd nuclei (Bi in the present case), and derive the wave-function for the 1^- level of Bi^{210} from the wave-functions of Pb^{210} and Po^{210} using the relations obtained from the β-decay anomalies.

539.14

13145 COULOMB EXCITATION OF Pt^{194} AND Pt^{195}.

R.Barloutaud, T.Grjebine, P.Lehmann, A.Lévêque, J.Quidort and G.M.Temmer.

J. Phys. Radium, Vol. 19, No. 5, 570-1 (May, 1958). In French.

Double coincidence measurements were used to identify cascades of γ-rays in the de-excitation of Pt^{194} and Pt^{195}. The excitation of the 620 keV level in Pt^{194} was confirmed. The results are discussed in relation to a level scheme for Pt^{195}.

A.Ashmore

539.14

13146 A STUDY OF THE EXCITED LEVELS IN B^{11} BY ANGULAR DISTRIBUTION AND CORRELATION MEASUREMENTS IN STRIPPING PROCESSES. M.Croissiaux.

Ann. Phys. (Paris), Ser. 13, Vol. 5, No. 3-4, 409-67 (March-April, 1960). In French.

The stripping process is dealt with quantitatively and predictions for intermediate coupling in B^{11} are derived. Experimental techniques for measuring the yield curves, angular distributions and (p,γ) angular correlations in the $B^{10}(d,p)\ B^{11}$ reactions are described. Measurements included the fundamental 2.14, 4.46, 5.03, 6.76, 6.81, 7.30, 9.19, and 9.28 MeV levels and the admixture of 4.46 MeV γ-radiation was deduced. Limits are placed on the possible spin values of the 6.76 MeV and 7.30 MeV levels and the parity of the latter determined.

S.E.Hunt

539.14 : 539.17

13147 EXCITED STATES OF P^{32}.

D.Piraino, C.H.Paris and W.W.Buechner.

Phys. Rev., Vol. 119, No. 2, 732-5 (July 15, 1960).

The proton groups from the $P^{31}(d,p)P^{32}$ reaction were studied at angles of 30°, 50°, 70°, and 90°. The incident deuteron energy was

6 MeV, and the protons were analysed with a broad-range magnetic spectrograph. Fifth-two excited states were found in the region between the ground state and 6.2 MeV in P^{32}.

539.14

13148 FIRST EXCITED STATE IN Ca^{42} AND Ca^{44}.
T.Komoda.
Progr. theor. Phys., Vol. 20, No. 4, 580-2 (Oct., 1958).

Values of the energy difference of the first excited states of Ca^{42} and Ca^{44} are calculated using the method of configuration mixing. A Rosenfeld force mixture of suitable range gives good agreement with experiment. E.A.Sanderson

539.14

13149 EXCITED STATES OF Cs^{134}.
A.S.Melioranskii, I.V.Éstulin, L.F.Kalinkin and B.S.Kudinov.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 758-64 (March, 1960). In Russian.

Cascade γ-transitions induced in caesium nuclei by thermal neutron capture were studied. The scheme of low-energy Cs^{134} levels of excitation energies up to 320 keV is discussed.

539.16

13150 ANGULAR CORRELATION OF INTERNAL CONVERSION PAIRS OF THE 3.560 MeV TRANSITION OF Li^6.
S.Gorodetzky, G.Sutter, F.Scheibling, P.Mennrath, P.Chevallier and R.Armbruster.
C.R. Acad. Sci. (Paris), Vol. 250, No. 20, 3308-9 (May 16, 1960). In French.

Comparison of the experimental results with theory shows that the transition possesses the character of a magnetic dipole (M1) or an electric quadrupole (E2), the measurements failing to distinguish between the two possibilities. The result indicates a positive parity for the second excited level of Li^6 and is in agreement with a spin 0 and a multipolarity of character M1 (Abstr. 6867 of 1954; 1912 of 1958). For the experimental arrangement used, see Abstr. 1752 of 1959. I.C.Demetsopoullos

539.14 : 539.17

BETA- AND GAMMA-VIBRATIONAL STATES IN Sm^{152}.
See Abstr. 11415

539.14

13151 MESONIC DECAYS OF HYPERFRAGMENTS.
G.C.Deka.
Nuovo Cimento, Vol. 14, No. 6, 1217-25 (Dec. 16, 1959).

A search for hyperfragments emitted from the nuclear interactions of 4.5 GeV π^--mesons and 300 MeV/c K^--mesons provided twenty-one decays of hyperfragments. Nine of these have been identified as specific hypernuclei from the momentum balance of the decay particles; their binding energies have been measured and found to be in good agreement with the results obtained by other authors.

539.14

13152 THE DECAY AND STRUCTURE OF HYPERFRAGMENTS. II. J.Szymański.
Nuovo Cimento, Vol. 15, No. 1, 45-51 (Jan. 1, 1960).

For Pt I see Abstr. 3840 of 1959. The energetic and angular distribution of the ${}_{\Lambda}He^5$ decay products is calculated. Several hyperfragment shape-functions are taken into account. The results indicate a very strong dependence on the hyperfragments structure.

539.14

13153 HYPERFRAGMENT PRODUCTION IN K^--MESON ABSORPTIONS AT REST IN NUCLEAR EMULSIONS. MESIC DECAYS. J.Sacton.
Nuovo Cimento, Vol. 15, No. 1, 110-20 (Jan. 1, 1960).

The results of the analysis of 26 mesic hyperfragment decays found in a sample of 2236 K^--meson stars (excluding K_{ρ}) are given. 9 hyperfragment decays have been uniquely identified. Among these, a new decay mode of the ${}_{\Lambda}Li^8$ hyperfragment was observed. The possible existence of a ${}_{\Lambda}He^6$ hyperfragment is also mentioned.

539.14 : 539.12

HYPERFRAGMENTS PRODUCED BY K^- CAPTURE IN NUCLEAR EMULSION. See Abstr. 13050

539.14

13154 MESIC DECAYS OF HYPERNUCLEI FROM K^--CAPTUR I. BINDING ENERGIES.
R.Ammar, R.Levi Setti, W.E.Slater, S.Limentani, P.E.Schlein and P.H.Steinberg.
Nuovo Cimento, Vol. 15, No. 2, 181-200 (Jan. 16, 1960).

The analysis of 134 uniquely identified mesic decays yields increased accuracy in the knowledge of the binding energies of the hyper-nuclides ${}_{\Lambda}H^3$, ${}_{\Lambda}H^4$ ${}_{\Lambda}He^4$, ${}_{\Lambda}He^5$, ${}_{\Lambda}Li^7$, ${}_{\Lambda}Li^8$, ${}_{\Lambda}Li^9$, and ${}_{\Lambda}Be^9$. In addition, individual examples of the new species ${}_{\Lambda}He^7$, ${}_{\Lambda}B^{11}$ and ${}_{\Lambda}B^{12}$ are described. The present data are combined with those collected in the EFINS survey. The isotopic spin multiplet structur of the light hypernuclei is discussed with reference to the information derived from the binding energies.

539.14

13155 SOME REMARKS ON THE CHARGED MESIC DECAY OF ${}_{\Lambda}H^3$. T.Ogimoto and Y.Yamaguchi.
Progr. theor. Phys., Vol. 17, No. 6, 817-19 (June, 1957).

The branching ratios of the competing processes in the decay of the hypertriton are calculated in the lowest order perturbation theory. [This work, performed early in 1957, still assumes that parity is conserved in the decay of the Λ-hyperon]. S.J.St-Lorant

539.14

13156 ON THE DEPTH OF THE POTENTIAL WELL FOR Λ-PARTICLES IN HEAVY HYPERNUCLEI.
V.A.Filimonov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1569-70 (May, 1959).
In Russian. English translation in: Soviet Physics—JETP (New Yor Vol. 36(9), No. 5, 1113-14 (Nov., 1959).

Contributions to the potential energy of Λ-particles in nuclear matter, corresponding to the exchange of a K, two π's, a K and a π, and two K-mesons, are determined for both scalar and pseudoscalar coupling between K-mesons and baryons, using the zero-range interaction approximation. The total potential energy obtained with scalar coupling is not in disagreement with values derived from uncertain experimental binding energies of Λ-particles in heavy hypernuclei but the pseudoscalar coupling gives too large a depth.
E.A.Sanderso

539.14

13157 ANOMALOUS DECAYS OF HYPERFRAGMENTS.
S.A.Azimov, U.G.Gulyamov, R.Karimova and B.G.Rakhimbaev.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 697-702 (March, 1960).
In Russian.

Two events of K-meson decay of hyperfragments are described. They are compared with previous hyperfragment decay-events and some common features are noted. It is shown that the events cannot be explained by statistical deviations of the characteristics of the particle tracks in the emulsion.

RADIOACTIVITY . NUCLEAR DECAY

539.16

13158 A SEMI-CIRCULAR MAGNETIC β SPECTROGRAPH WITH PHOTOGRAPHIC DETECTION AND POST-ACCELERATION. J.Delesalle.
J. Phys. Radium, Vol. 19, No.1, 111 (Jan., 1958). In French.

A high resolution spectrograph is described in which electrons are accelerated after deflection in the semicircular magnet but before reaching the photographic emulsion. Since the acceptance ang is unaffected this type of spectrograph is more useful than the pre-acceleration type for measuring relative intensities of β particle groups of different energy. S.E.Hunt

539.16

13159 RECALIBRATION OF THE NBS CARBON-14 STANDAR BY GEIGER-MÜLLER AND PROPORTIONAL GAS COUNTING. W.B.Mann, H.H.Seliger, W.F.Marlow and R.W.Medloc
Rev. sci. Instrum., Vol. 31, No. 7, 690-6 (July, 1960).

Compensated internal gas counters have been constructed for th recalibration of the National Bureau of Standards C^{14} solution standards. Satisfactory agreement has been obtained by counting in bot the proportional and Geiger regions.

539.16

13160 **DETERMINATION OF RADON IN THERMAL SPRINGS.** B.Čerček.

Stefan" Inst. Rep., Vol. 3, 79-85 (Oct., 1956).

The paper describes a radiometric method and apparatus for ntitative assay of radon in liquids. The lower limit of detection bout 10^{-11} curie of radon activity. A survey of radioactivity of most important Slovenian thermal springs is added.

539.16

.3161 **AN EVALUATION OF EXISTING FALLOUT COLLECTION METHODS.** G.A.Welford and W.R.Collins, Jr.

ence, Vol. 131, 1791-3 (June 17, 1960).

Analysis of data shows that open vessels and funnels are ally efficient for fallout sampling.

539.16

13162 **PROPOSAL OF AN EXPRESSION OF THE RELATIVE DANGER OR RISK (H) OF A RADIOISOTOPE AND OF E DANGER OR RISK CORRESPONDING TO A RADIOACTIVITY EMITTED BY THE RADIOISOTOPE.** P.Q.Robert.

Phys. Radium, Vol. 19, Suppl. No. 7, 117A-119A (July, 1958). French.

539.16 : 550.9 : 539.1.07

13163 **A STUDY OF THE RADIOACTIVITY OF SOME PEGMATITE FROM RENFREW, ONTARIO, CANADA.** A.Hée.

article photography" Conference. Montreal, 1958 (see Abstr. 31 of 1960) p. 444. In French.

The zircon age of a pegmatite from Renfrew, Canada was ermined by Larsen's method. Possible reasons for the discrepcy between this age, 1.8 × 10^9 years, and that determined massectrographically are briefly discussed. S.J.St-Lorant

539.16 : 551.5

13164 **USE OF LONG-LIVED NATURAL RADIOACTIVITY AS AN ATMOSPHERIC TRACER.**

M.Burton and N.G.Stewart.

ture (London), Vol. 186, 584-9 (May 21, 1960).

It is suggested that the long-lived daughter products of radon a-D, -E and -F), which are naturally present in the atmosphere as result of the leakage of radon from soils and rocks on the Earth's rface, could be used to study the mechanism of the transport of from troposphere to stratosphere. The development of a radioemical procedure for separating these isotopes is described. The sults of a preliminary study of the distribution of radium-D and dium-F in the atmosphere are given. It is concluded from these sults that radium-D is a valuable natural tracer for the further idy of atmospheric processes. C.F.Barnaby

539.16 : 61

13165 **RADIATION PROCESSING OF FOODS.** R.J.Beeley.

iclear Sci. Engng, Vol. 3, No. 6, 660-93 (June, 1958).

In a study made for the U.S.Army Quartermaster Corps, all the known types of radiation sources of sufficient size to be of terest in large scale radiation processing were compared. The urces considered are spent fuel elements from a power reactor, ssion product gases from a fluid-fuel reactor, separated fission oduct Cs^{137}, reactor-coolant Na^{24}, neutron-activated In^{116m} charged rticle accelerators and X-rays. This paper summarizes the relts of the study.

539.16

13166 **ISOTOPIC ANALYSIS: CERIUM-141 AND CERIUM-144.** W.S.Lyon.

iclear Sci. Engng, Vol. 4, No. 6, 709-12 (Dec., 1958).

Ce^{141} and Ce^{144} are determined in the presence of each other by rforming a suitable cerium chemical separation and then measung the radiation from each nuclide. Ce^{144} is determined by counng the 3.0 MeV Pr^{144} beta ray; Ce^{141} is determined by integrating neath the 145 keV gamma-ray peak observed with a sodium iodide mma-ray spectrometer. In the latter case correction for contritions from Ce^{144} must be made. The gamma/beta branchings for e 145 keV gamma ray in Ce^{141} and the 134 keV gamma ray in Ce^{144} ere determined.

539.16

13167 **THE APPLICATION OF A RANDOM FUNCTION X(t) = ±1 TO THE STUDY OF THE LAWS OF DISINTERATION OF DECAY CHAINS OF RADIO-ELEMENTS.**

Landaud and C.Mabboux.

C.R. Acad. Sci. (Paris), Vol. 250, No. 20, 3310-13 (May 16, 1960). In French.

The auto-correlation function of the response of a bistable system is calculated, when the latter is triggered by the pulses produced in a detector by the radiation of a radioactive element. The case of simple disintegration is treated separately as the production of a radioactive daughter, or as due to the presence of a metastable state, the mother-to-daughter disintegration ratio being taken into account. S.J.St-Lorant

539.16

13168 **NUCLEON EMISSION BY A ROTATING NUCLEUS.** G.A.Pik-Pichak.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 768-72 (March, 1960). In Russian.

The effect of a large angular momentum on nucleon emission by an excited nucleus is determined in the independent-particle model. The mean characteristics of neutron emission as a function of temperature and angular momentum are calculated. An estimate is made of the mean excitation energy which remains after emission of the nucleons and which is carried off by the γ-quanta.

539.16

13169 **NUCLEAR ISOMERS OF Ir^{192} AND Ir^{194}.** H.H.Hennies.

Z. Phys., Vol. 159, No. 2, 158-69 (1960). In German.

The β- and γ-radiation of Ir^{192} and Ir^{194}, produced by slow neutron irradiation, was studied with scintillation spectrometers. A new isomeric activity with a (47 ± 2) sec half-life is found to be Ir^{194m}, decaying by a 130 keV transition to Ir^{194} and by β-emission to excited states of Pt^{194}. Gamma rays of energy (130 ± 4), (323 ± 7) and (625 ± 20) keV were found. An upper limit for conversion coefficient of the isomeric transition is given, which shows, in connection with energy—half-life relations, that the 130 keV gamma ray is an E3 transition.

539.16

13170 **DECAY OF Ba^{133}.** M.K.Ramaswamy, W.L.Skeel and P.S.Jastram.

Nuclear Phys., Vol. 16, No. 4, 619-24 (June (1), 1960).

The gamma-rays following the electron-capture decay of 7.5 year Ba^{133} were studied by means of a coincidence-scintillation spectrometer. Gamma-rays at 79, 79, 274, 302, 358 and 381 keV were observed. In addition, the presence of a 56 keV gamma-ray was confirmed. The resulting decay scheme with levels at 79, 158, 381 and 437 keV is in excellent agreement with previous work. Spin and parity assignments are made for these levels in Cs^{133}.

539.16

13171 **SPINS AND DECAY MODES OF CERTAIN NEUTRON-DEFICIENT SILVER ISOTOPES.**

O.Ames, A.M.Bernstein, M.H.Brennan, R.A.Haberstroh and D.R.Hamilton.

Phys. Rev., Vol. 118, No. 6, 1599-604 (June 15, 1960).

Isotopically enriched Pd foils were bombarded with protons to determine the orgin of the 1.2 hr activity which was previously discovered in an even-A Ag isotope. The only appropriate activity was found in Ag^{104} which was observed to have a (69 ± 3)-min predominantly K-capture activity with intense γ-rays of 550, 764, and 920 keV. Using the atomic beam magnetic resonance method it was verified that the 69-min activity has I = 5. The I = 2 resonance in Ag^{104}, when counted in an X-ray detector, was found to decay with a 69-min half-life with a small admixture of a 27-min component. When viewed in a β-counter, only the 27-min component is observed. These characteristics of the I = 2 resonance can be explained by placing the I = 2 level above the I = 5 level with an appreciable amount of isomeric transition. This interpretation is supported by the observation of feeding in the 920 keV γ-ray which only occurs in the decay of the I = 5 state. Further work with isotopically-enriched Pd foils showed γ-rays of 120 and 150 keV, and, tentatively, 260 keV which have been assigned to the decay of 59-min Ag^{102}. A positive identification of a (15 ± 2)-min activity on Ag^{102} has been made.

539.16

13172 **RADIOACTIVE DECAY OF Tm^{166}.** R.G.Wilson and M.L.Pool.

Phys. Rev., Vol. 119, No. 1, 262-6 (July 1, 1960).

Erbium oxide enriched to 72.9% in the 166 mass number was irradiated with 6 MeV protons. An activity decaying by electron capture and positron emission with a half-life of 7.69 ± 0.05 hr was produced by a (p,n) reaction and its assignment to Tm^{166} was confirmed. The observed activity consists of the K X-ray of erbium, gamma rays with energies of 81, 184, 289, 405, 460, 598, 674, 694, 707, 759, 782, 788, 878, 1052, 1179, 1276, 1351, 1589, 1874, and 2058 keV, annihilation radiation, and particle radiation with an end-point energy of 2090 ± 40 keV. Gamma–gamma coincidence measurements and consideration of the energies and relative numbers of the observed radiations have led to the assignment or confirmation of energy levels at 81 (2+), 265 (4+), 554 (6+), 788 (2+), 863 (3+), 959 (4+), 1248 (2), 1317 (5), 1462 (0+), 1547 (3+), 1701 (4+), 1894 (5+), 2139 (3), and 2168 (0) keV in Er^{166}. The 2139 keV is highly populated by electron capture and the positron transitions occur to the 265 (4+) keV level. The positions of the observed radiations and the branching ratios of electron capture are shown in a proposed energy-level scheme.

539.16

13173 DECAY OF Ga^{66} AND Cu^{66}.

A.Schwarzschild and I.Grodzins.

Phys. Rev., Vol. 119, No. 1, 276-86 (July 1, 1960).

The 9.5 hr decay of Ga^{66} and the 5.1 min decay of Cu^{66} were studied by a variety of techniques including gamma-ray spectroscopy, internal conversion measurements, and angular correlation studies. All but one of the 18 gamma-rays observed were ordered into a structure of 11 levels, and the spins and parities of all but one of these levels were determined. It is shown that Ga^{66} has spin zero and even parity and that its 4.166 MeV β-spectrum is a pure Fermi transition. The energy of the internal conversion line of the 4.300 ± 0.005 MeV transition was measured with great care and this line may be useful for spectrometer calibration. The second excited state of Zn^{66}, at 1.875 MeV, has 2+ spin and parity. The stopover transition from this state contains at least 10% M1 radiation: the stopover to crossover ratio is greater than 100 to 1.

539.16

13174 DECAY OF 6.3 MIN Br^{78}.

W.R.Pierson and C.D.Coryell.

Phys. Rev., Vol. 119, No. 2, 755-60 (July 15, 1960).

The nuclide 6.3 min Br^{78} was made by the reactions (γ,n),(n,2n), (p,n),(d,2n), and(α,n), and its decay properties were investigated by positron decay-curve analysis, by application of a standard chemical isomer-separation procedure, by searching for conversion electrons, and by studying the gamma-ray and positron-gamma-coincidence spectra. The early portion of the positron decay curve exhibited a single 6.25 ± 0.2 min component, and no active daughter of this species was chemically separable from active CBr_4. Conversion electrons were not found, and soft gamma rays were shown to be absent. There are 12 keV X-rays, of intensity about 0.05 relative to the positrons, and therefore presumed to be K X-rays of Se resulting from electron capture. These results show that 6.3 min Br^{78} has no daughter isomer and probably no >10 sec parent isomer. There is a 615 keV gamma ray, in coincidence with positrons, and of intensity 0.139 that of all positrons, representing decay of Br^{78} to Se^{78} in the 615 keV 2 + state. However, no evidence for decay to Se^{78} in the 1.32 MeV state could be found. From these data it was deduced that 6.3 min Br^{78} decays 81% by positron emission and 6% by electron capture to ground-state Se^{78}, 11% by positron emission and 2% by electron capture to Se^{78} in the 615 keV state, and < 1% to Se^{78} in the 1.32 MeV state. The disintegrations of Br^{78} to Se^{78} in the ground state and 615 keV state have log ft values of 4.8 and 5.2, respectively, indicating that the spin of ground-state Br^{78} is 1, with even parity. The absence of isomerism is discussed in terms of the locations of expected energy levels, with reference to the known locations of these levels in Br^{83}.

539.16

13175 DECAY OF ${}_{66}Dy^{166}$.

R.G.Helmer and S.B.Burson.

Phys. Rev., Vol. 119, No. 2, 788-95 (July 15, 1960).

Dy^{166} was produced by successive neutron capture in stable Dy^{164} This isotope decays by beta-ray emission with an 80.2 hr half-life to states in Ho^{166}. This isotopic assignment of previous authors is confirmed. Separations of the parent and daughter activities were carried out by use of an ion-exchange column. Scintillation studies were made with a 256-channel scintillation coincidence spectrometer. Internal-conversion electrons were measured in magnetic spectrographs with permanent magnets and the continuous beta spectra were observed with a 180° magnetic spectrometer with a variable field. The seven gamma-ray transitions observed had energies of 28.1, 54.2, 82.5, 288, 344, 375, and 428 keV. Beta-ray branches of 481 and 402 keV were observed with the magnetic spectrometer; two others of 114 and 56 keV are postulated for the decay scheme. The decay scheme presented indicates the existence of five levels in Ho^{166} at $0(0^-)$, $54(2^-)$, $82(1^-)$, 370, and 428 (1^+) keV. The ground state and first two excited states are interpreted as members of a rotational band with K = 0. This interpretation implies that in odd–odd nuclei the level sequence can be inverted for the first two excited states of such a band.

539.1

13176 HALF-LIFE OF IRIDIUM 192.

J.W.Allison.

Brit. J. appl. Phys., Vol. 11, No. 7, 302-4 (July, 1960).

Using a null method, an ionization chamber and vibrating reed electrometer were employed to compare the γ-ray activity of an Ir^{192} source with that of a reference Ra^{226} source over a period of 209 days. An analysis of the results by the method of least square indicates a half-life of Ir^{192} of 74.17 ± 0.07 days.

539.1

13177 HALF-LIFE OF 2.7-DAY Au-198.

C.Sastre and G.Price.

Nuclear Sci. Engng, Vol. 1, No. 4, 325-6 (Aug., 1956).

The half-life of 2.7 day Au^{198} has been measured, using end-window Geiger counters, over a period of 24 days, and found to be 2.694 ± 0.006 days.

539.16 : 539.1

RADIOACTIVITY OF NUCLIDES NEAR A= 190.

See Abstr. 13142

539.1

13178 HALF-LIVES OF RADIONUCLIDES. I.

H.W.Wright, E.I.Wyatt, S.A.Reynolds, W.S.Lyon and T.H.Handley.

Nuclear Sci. Engng, Vol. 2, No. 4, 427-30 (July, 1957).

Half-lives of thirty radionuclides are reported. Most of the samples were chemically purified after bombardment. In general, the activity of a given sample was followed for two or more half-lives, employing a gamma ionization chamber, gamma scintillation counter, or a G.M. counter. The data were analyzed by the least squares method. Some of the half-life values are significantly different from earlier ones; others merely confirm those already established.

539.1

13179 HALF LIVES OF N^{16}, Mg^{27}, Al^{28}, S^{37}, AND Rh^{104m_2}.

J.O.Elliot and F.C.Young.

Nuclear Sci. Engng, Vol. 5, No. 1, 55-6 (Jan., 1959).

Scintillation detector studies were performed on the disintegra tion rate of five nuclides produced at the NRL research reactor. T nuclides together with their measured half lives are: N^{16}, 7.352 ± 0.009 sec; Mg^{27}, 0.54 ± 0.08 min; Al^{28}, 2.305 ± 0.006 min; S^{37}, 5.07 ± 0.01 min; Rh^{104m_2}, 4.41 ± 0.02 min.

539.1

13180 LIFETIMES OF THE FIRST EXCITED STATES OF Rb^{85} AND Pr^{141}.

N.A.Burgov, A.V.Davȳdov and G.R.Kartashov.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1946-7 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York Vol. 36(9), No. 6, 1384-5 (Dec., 1959).

The lifetimes were measured by the method of delayed β–γ coincidences, and found to be: $\tau_\gamma(Rb^{85}) = (1.14 \pm 0.12) \times 10^{-9}$ sec; $\tau_\gamma(Pr^{141}) = (2.32 \pm 0.17) \times 10^{-9}$ sec. A.Ashmor

539.16

13181 BRANCHING OF TRANSITIONS IN SOME MIRROR NUCLEI.

W.L.Talbert, Jr and M.G.Stewart.

Phys. Rev., Vol. 119, No. 1, 272-7 (July 1, 1960).

The possibility of branching in the decays of Na^{21}, Mg^{23}, Al^{25}, Si^{27}, S^{31}, and Ca^{39} was investigated using NaI(Tl) scintillation detectors. The nuclear gamma rays emitted as a result of branching transitions were detected in coincidence with the accompanying pos tron annihilation radiation. Branching was found to the first excite states of the daughter nuclei in the decays of Na^{21}, Mg^{23}, and S^{31}, wi intensities (compared to the total decay) of 2.2, 9.1 and 1.1% respec ively. The decays of Al^{25}, Si^{27}, and Ca^{39} were found to have no detectable branching to the lower excited states of the daughter nucle and upper limits of < 1% were placed on the branching ratios for branches. The lack of branching in the decay of Al^{25} to the MeV level of Mg^{25} favours a unified model description for the ear states involved.

539.16

182

ON THE THEORY OF α-DECAY.

H.J.Mang.

Heidelberg. Akad. Wiss. (Math. Nat. Kl), 1959, No. 6, 299-324. erman.

Discusses the derivation and interrelation between expressions he decay constant. R.H.Thomas

539.16

3183

ABSOLUTE DETERMINATION OF SOME ALPHA-PARTICLE ENERGIES.

A.Rytz.

. Acad. Sci. (Paris), Vol. 250, No. 19, 3156-8 (May 9, 1960). rench.

Describes the absolute measurement of the alpha-particle rgies emitted by Po^{210}, Po^{212}, Po^{214}, Bi^{211} and Bi^{212}. The results ined agree well with those previously published. A magnetic ctograph was used with the field controlled by nuclear magnetic nance. R.H.Thomas

539.16

3184

STATES OF EVEN—EVEN NUCLEI IN THE NEAR-HARMONIC REGION: SPECTRA OF Rn^{218}, Rn^{220},) Rn^{222}.

F.S.Stephens, F.Asaro, and I.Perlman.

s. Rev., Vol. 119, No. 2, 796-805 (July 15, 1960).

Gamma-ray singles and coincidence spectra were measured in alpha decay of Ra^{222}, Ra^{224}, and Ra^{226}. Excluding the prominent sitions from the first excited states, the energies (and abundances tive to total α-emission) of the observed radiations were: Ra^{222}: keV(8.4×10^{-5}), 475 keV (7×10^{-5}), 525 keV (2×10^{-5}), and keV (2.5×10^{-4}); Ra^{224}: 290 keV (9×10^{-5}), 410 keV (4×10^{-5}), keV (6×10^{-5}); Ra^{226}: 260 keV (0.9×10^{-4}), 420 keV (7×10^{-6}), keV (3×10^{-6}), 610 keV (1.0×10^{-5}). The observed gamma—ma coincidences were Ra^{222}: 325-325, 325-475, and 325-525 keV; ^{24}: 241-290 and 241-410 keV; Ra^{226}: 188-260 and 188-420 keV. It not strictly determined that the Ra^{222} radiations were not due to er members of the Th^{226} family. These data were used to deduce owing levels, spins, and parities in the daughter Rn nuclides: ^{18}: 650 keV, 2+; 800 keV, 1−; and, possibly, 850 keV, 4+. Rn^{220}: keV, 2+; and 650 keV, 1−. Rn^{222}: 448 keV, 2+; and 610 keV, 1−. 2+ states in Rn^{220} and Rn^{222} have been previously assigned by arff-Goldhaber (1956). These results are incorporated in eral energy-level systematics of even—even nuclei in the heavy nent region.

539.16

13185

CALCULATION OF α-TRANSITION PROBABILITIES.

H.J.Mang.

s. Rev., Vol. 119, No. 3, 1069-75 (Aug. 1, 1960).

The decay rates for the ground-state transitions of all polonium topes and the odd—even astatine isotopes are discussed on the is of the nuclear shell model. Good agreement with experimental a is obtained. In particular the behaviour of the reduced width as nction of the neutron number around the magic number N = 126 vell reproduced.

539.16

13186

ON THE DETERMINATION OF NUCLEAR DEFORMATION FROM THE ALPHA-DECAY FINE STRUCTURE.

.Nosov.

eksper. teor. Fiz., Vol. 37, No. 3(9), 886-7 (Sept., 1959). Russian. English translation in: Soviet Physics—JETP (New York), . 37(10), No. 3, 631-3 (March, 1960).

The author has previously shown (Abstr. 5586 of 1957) that, on basis of α-particle fine-structure measurements, it is possible to calculate the quadrupole deformation parameter α_2 in the ression for the surface of the daughter nucleus $R(\cos\theta) = {}_0\{1 + \alpha_2 P_2(\cos\theta)\}$ from the experimentally observed probability excitation w_2 of the 2^+ rotational level. The calculation requires wledge of the wave-function of the α-particle at the nuclear sur-e, which can be deduced in the case of even-even nuclei. The culation was carried out for 22 even-even daughter nuclei, results compared with those of Strutinskii (Abstr. 2535 of 1958) used a different method but the same physical assumptions. R.E.Meads

539.16

13187

ALPHA DECAY OF Th^{229}. INTERACTION OF NUCLEAR LEVELS.

L.L.Gol'din, G.I.Novikova, N.I.Pirogova and E.F.Tret'yakov.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1155-7 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 822-4 (April, 1960).

The alpha decay spectrum of Th^{229} was investigated with a magnetic α-spectrometer and 12 α lines were found. A number of lines in the electron conversion spectrum of the daughter nucleus, Ra^{225}, were observed but a full interpretation of these is still lacking. S.J.St.Lorant

539.16

13188

ON THE PROBABILITY OF DOUBLE BETA DECAY.

F.Janouch.

Czech, J. Phys., Vol. 10, No. 1, 1-6 (1960).

Double beta decay is discussed in relation to parity non-conservation. Two possible ways of neutrino-less double beta decay (allowed and forbidden) are investigated and the half-life is calculated. For allowed transitions, one obtains for Ca^{48} an estimated $T_{1/2} = 2 \times 10^{19}$ years. The negative results of the experiments of Dobrokhotov et.al. (Abstr. 10066 of 1959), who give the value $T_{1/2} = 0.7 \times 10^{19}$ years for the lower limit of the half-life of double beta decay of Ca^{48}, cannot therefore be regarded as a definitive solution of the question, whether the neutrino is a Dirac or Majorana particle. Further study of double beta decay, aimed at finding higher values of the lower limit of half-life are of considerable importance for theory.

539.16

13189

MESIC CORRECTION TO THE BETA-DECAY IN A NUCLEUS.

J.Fujita, Z.Matumoto, E.Kuroboshi and H.Miyazawa.

Progr. theor. Phys., Vol. 20, No. 3, 308-14 (Sept., 1958).

Mesic correction to beta-decay interactions are investigated. It is found that the Gamow—Teller coupling should apparently become about 8% smaller by exchanging pions among nucleons. Also the mesic effect in the l-forbidden case is discussed.

539.16

13190

COMMENTS ON THE COVARIANTS IN THE BETA-DECAY INTERACTION.

B.N.Valuev.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1578-80 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1121-2 (Nov., 1959).

Higher-order corrections to the first-order perturbation approximation in the four-fermion interaction theory of beta-decay were considered under the assumption that the cutoff introduced to the theory was large compared with the nucleon mass and with the total centre-of-mass energies considered. For this case it was shown that, in particular for the V—A interaction, but also for certain other combinations of invariants, the higher-order corrections do not change the structure of the results, and it was still possible to determine from experiment which covariants occur in the Hamiltonian. R.F.Peierls

539.16

13191

THE "COMPLETE EXPERIMENT" IN β-DECAY.

Ya.A.Smorodinskii.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1606-8 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1142-3 (Nov., 1959).

The number of form-factors required for various transitions is considered. W.A.Hepner

539.16

13192

EFFECT OF DEFORMATION OF THE NUCLEUS ON THE ELECTRON WAVE-FUNCTIONS. APPLICATION TO β-DECAY.

R.Vainer and Kh.Yusim.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 870-6 (March, 1960). In Russian.

The effect of quadrupole interaction on the wave-functions of the electron—nucleus system is studied. The electron and nuclear variables cannot be separated in the case of nonspherical nuclei. As a consequence the "satellite" nuclear (I) and the electron (j) angular momenta appear, which satisfy the inequalities $|I-I_0| \leq 2$ and $|j-j_0| \leq 2$, where I_0 and j_0 are the total nuclear and electron angular momenta in the absence of quadrupole interaction. The wave-function for the electron—nucleus system is found by perturbation theory methods for nuclei with axial symmetry. The explicit expression of the wave-functions in the region r ≤ R (R is the nuclear radius) is presented. "Satellite" states lead to the appearance of new matrix elements which in some cases significantly change the probability of the corresponding transitions. In the case of β-decay for $Z \sim 70$, $Q_0 \sim 5 \times 10^{-24}$ cm^2 and $\Delta I \geq 3$, (where ΔI is the difference between the initial and final state nuclear spins) the new matrix elements may exceed those computed without allowance for the above effect by 1–2 orders of magnitude.

539.16 : 539.12

INTERNAL BREMSSTRAHLUNG IN β-DECAY OF POLARIZED NUCLEI. See Abstr. 12900

539.16

13193 THE AVERAGE BETA ENERGY AND THE DECAY CONSTANT OF TRITIUM.

M.M.Popov. Iu.V.Gagarinskii, M.D.Senin, I.P.Mikhalenko and Iu.M.Morozov.

J. nuclear Energy, Vol. 9, No. 1-4, 190-3 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 296 (1958).

The average energy of tritium β-particles was measured by a calorimetric determination of the heat output of a known quantity of tritium absorbed in palladium. The method of preparation of the uranium tritide samples is described in detail. The result obtained, 5.52 ± 0.01 keV, is in agreement with values obtained by integrating the tritium β-spectrum. It was found that the heat output decreased exponentially with time thus confirming that no additional heat sources were present and yielding a value $\lambda = 150.8 \times 10^{-6}$ days^{-1} for the tritium decay constant, corresponding to a half-life T = 12.58 ± 0.18 years.

I.C.Demetsopoullos

539.16

13194 BETA-DECAY THEORY AND THE SPECTRUM OF Rb^{87}.

M.A.Preston, G.H.Keech and J.M.Pearson.

Phys. Rev., Vol. 119, No. 1, 305-10 (July 1, 1960).

The shape of the third forbidden β-spectrum of Rb^{87} is analysed. It is found to be consistent with (a) a mixture of vector and axial vector interactions; (b) the same value and sign of the ratio g_A/g_V as found for the neutron, and (c) a shell model evaluation of the nuclear matrix elements.

539.16

13195 EVIDENCE FOR SMALL DEVIATIONS IN THE ALLOWED POSITRON SPECTRUM OF Zr^{89}.

J.H.Hamilton, L.M.Langer and W.G.Smith.

Phys. Rev., Vol. 119, No. 2, 772-6 (July 15, 1960).

The decay of Zr^{89} was carefully studied with magnetic and scintillation spectrometers, with special emphasis on the detailed shape of the positron spectrum. The decay scheme was verified. The positron decay is by a single, allowed group followed by a single 915 keV gamma ray. The Zr^{89} spectrum has a nonstatistical shape corresponding to an excess of low-energy beta particles. Theoretical refinements for screening and finite de Broglie wavelength were applied but were found to be much too small to explain the observed deviation from a statistical spectrum. The same shape factor that was found to fit the In^{114}, Y^{90}, P^{32}, and Na^{22} data (in addition to the once forbidden, unique shape factor for Y^{90}) also fits the Zr^{89} data, i.e., $(1 + b/W)$ with $0.2 \leq b \leq 0.4$. It is significant that the deviation has the same direction and approximate magnitude as was found for the electron spectra.

539.16

13196 β-DECAY OF P^{32}.

B.V.Geshkenbein.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1341-2 (April, 1960). In Russian.

The β-spectrum and polarization in this allowed transition differ from pure Fermi predictions. It is suggested that this is a result of relative importance of second forbidden contributions, due to the smallness of the matrix element; (log ft is 7.9). A formula is derived for the corrections to the spectrum and polarization, from the universal theory of weak interactions. The observed data can be fitted with values of parameters in the expected range.

D.W.L.Sprung

539.16 : 539.14

DETERMINATION OF THE CONFIGURATION MIXING IN RaE FROM THE β^--DECAYS $Pb^{210} \rightarrow Bi^{210} \rightarrow Po^{210}$. See Abstr. 13144

539.16

13197 HIGHER-ORDER EFFECTS IN THE ALLOWED β-DECAY OF Li^8.

K.Krebs, H.Rieseberg and V.Soergel.

Z. Phys., Vol. 159, No 2, 232-6 (1960). In German.

The β–α angular correlation of Li^8 was measured at electro energies of 3.5 and 7.0 MeV. The β-energies were selected by a magnetic lens spectrometer. Subtracting the contribution of kinematic effects, one finds for the coefficient b of the $\cos^2\Theta$ term, $b = (1.9^{+2.6}_{-2.3})\%$ at 3.5 MeV, and $b = (4.0^{+2.0}_{-1.3})\%$ at 7.0 MeV. This res is in reasonable agreement with theoretical predictions.

539

13198 BRANCHING RATIOS OF K CAPTURE TO POSITON EMISSION IN NON-UNIQUE FIRST FORBIDDEN $2^- \rightarrow 2^+$ BETA TRANSITIONS.

J.Konijn, B.van Nooijen and A.H.Wapstra.

Nuclear Phys., Vol. 16, No. 4, 683-9 (June (1), 1960).

The ratio of K-capture to positron emission in $2^- \rightarrow 2^+$ transitions cannot always be explained by admixture of unique forbidd transitions in transitions having essentially an allowed K/β^+ ratio On the other hand, the normal theory for transitions with $|\Delta J| = 1$ gives values for As^{74}, Rb^{84}, I^{126} and Tl^{200} which do not depend heav on the actual values of matrix elements and which nearly agree wi the experimental ones.

539.

13199 β–γ DIRECTION CORRELATION IN ^{152}Eu.

S.K.Bhattacherjee and S.K.Mitra.

Nuovo Cimento, Vol. 16, No. 1, 175-89 (April 1, 1960).

The directional correlation between the first forbidden 1483 k β-group and the 344 keV E2 γ-transition in the decay of 13 yr Eu^{15} was measured as a function of β-energy above 950 keV. The integ β–γ correlation data for β-energies above 950 keV can be fitted w a directional correlation function

$$W(\theta) = 1 - (0.379 \pm 0.004) \cos^2 \theta.$$

The anisotropy is negative and is found to increase with β-energy, its value is −0.416 ± 0.012 at 1350 keV, the maximum energy at which measurements were made. The energy dependence of the anisotropy excludes the unique character of the β-transition. The observed energy dependence of the anisotropy is fitted with the (V—A) theory in the modified B_{ij} approximation yielding two valu of the matrix element ratio $Y = -(C_V/C_A)(\int i\alpha / \int B_{ij}) \cong 1.05$ or 0.09. The former value of Y, however, reproduces closely the spectral shape recently observed for the 1483 keV β-group.

539.

13200 POLARIZATIONAL β–γ CORRELATION IN THE β-DECAY OF Co^{60}.

V.M.Lobashev, V.A.Nazarenko and L.I.Rusinov.

Zh. eksper. teor. Fiz., Vol. 37, No. 6(12), 1810-11 (Dec., 1959). In Russian.

A determination is reported of the correlation between transversely polarized electrons and circularly polarized photons in th β-decay of Co^{60}. The experiment was so arranged that the momen of the electron was in a plane perpendicular to the momentum k of the circularly polarized photon, the electron spin being antiparalle to k. The correlation is expressed in the form $W(\sigma) = 1 + A\sigma$ (cf. A.Z.Dolginov, Abstr. 2742 of 1959). The measured value of th parameter A was found to be 0.32 ± 0.12 as compared with the the retical value of 0.24 reported by Dolginov.

S.Chom

539.

13201 BETA- AND GAMMA-SPECTRA OF THE ISOTOPES Sb^{113} AND Sb^{115}.

V.L.Chikhladze, D.E.Khulelidze and I.P.Selinov.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1353 (April, 1960). In Russi

The beta-spectrum of Sb^{113} was found to have two components upper energies 1.85 ± 0.02 MeV and 2.42 ± 0.02 MeV, and log ft values 4.4 and 4.7 respectively; that of Sb^{115} had a single componen of upper energy 1.51 ± 0.02 MeV and log ft = 4.25. From internal-conversion measurements the gamma-spectrum of Sb^{115} was found to have a line at 0.499 ± 0.002 MeV and $\alpha_K = 0.00625$ ($\alpha_K/\alpha_L \cong 6$) Eight gamma-lines were observed, but not measured, in the Sb^{113} spectrum, by means of a scintillation spectrometer.

J.W.Gardne

539.

13202 ACCURATE METHOD FOR MEASURING INTERNAL CONVERSION COEFFICIENTS.

D.C.Lu.

Phys. Rev., Vol. 119, No. 1, 286-88 (July 1, 1960).

To reveal the effect on internal conversion due to nuclear structure and extension, measurements are needed which have higher accuracy than is attainable from currently used methods. The author describes how, under certain conditions, the absolute ie of the total internal conversion coefficient can be measured to 5% by the use of a large NaI(Tl) detector with a thin well-type dow. Complications encountered in the comparison between erimental and computed values are mentioned.

539.16

13203

ANGULAR CORRELATION IN INTERNAL CONVERSION, INCLUDING EFFECTS OF SCREENING AND OF THE NITE SIZE OF THE NUCLEUS.

A.K.Ustinova.

eksper. teor. Fiz., Vol. 37, No. 1(7), 307-8 (July, 1959). In ssian. English translation in: Soviet Physics—JETP (New York), .. 37(10), No. 1, 216-18 (Jan., 1960).

The effects of screening and of the finite nuclear size on the efficients involved in the expression for the angular correlation ween a K-shell conversion electron and subsequent radiation are culated. These effects become important for certain transitions.

E.J.Squires

539.16

13204

TRANSITIONS FOLLOWING THE DECAY OF Se^{75}.

M.de Croës and G.Bäckström.

k. Fys., Vol. 16, Paper 47, 567-79 (1960).

The conversion electron spectrum and the gamma ray spectrum ve been re-investigated by means of a double focusing spectroter. Conversion coefficients have been determined relative to the keV transition in Tl^{203}, mainly in order to investigate an E0 adxture which according to previous works seemed to exist in the keV transition. The multipolarity was however found to be pure , with a maximum E0 admixture of 6×10^{-3}. The conversion coicients generally support previous spin assignments. Transition ergies also support all features of a published decay scheme. Two ditional transitions have been found which are not accommodated the known levels. An electron-gamma coincidence experiment s made in an attempt to locate these transitions.

539.16

13205

GAMMA RADIATION IN THE DECAY OF Ag^{113}.

A.Kjelberg, H.Taniguchi and L.Yaffe.

nad. J. Phys., Vol. 38, No. 6, 866-8 (June, 1960).

The γ-spectrum of Ag^{113}, free of 3.2 hour Ag^{112}, was obtained th a 3 × 3 in.NaI(Tl) crystal feeding into a 100-channel pulse height alyser. All the γ-peaks decayed with a 5,3 hour half-life. rrections were made for a small contribution (~10%) in the ighbourhood of the 0.30 MeV peak due to 7.5 day Ag^{111}. The energies the γ-rays and their relative abundance are presented in tabular rm, and a tentative decay scheme for Ag^{113} is constructed using all rrently available data.

I.C.Demetsopoullos

539.16 : 539.14

PARTIAL GAMMA RAY WIDTHS FOR LOW LYING LEVELS IN LUMINIUM AND MAGNESIUM.

See Abstr. 13139

539.16

13206

GAMMA RADIATIONS OF Na^{23} AND Ne^{20}.

T.H.Kruse, R.D.Bent and L.J.Lidofsky.

hys. Rev., Vol. 119, No. 1, 289-304 (July 1, 1960).

Na^{23} and Ne^{20} gamma rays were observed from the proton mbardment at various energies of thin evaporated Na and NaI rgets and of a natural Ne gas target. Gamma rays involving Na^{23} ates up to 4 MeV and Ne^{20} states up to 5 MeV were observed and ecay schemes and branching ratios obtained. The 2.08 and 2.70 MeV ates of Na^{23} are probably 7/2^{+} and 9/2^{+} respectively. Limitations n spin and parity values are given for other states. The results btained for Na^{23} are consistent with the results of a strong-coupling llective calculation. The 4.97 MeV state of Ne^{20} has an upper mit for the ground-state branch of 4%. An upper limit of 9% is laced on the ground-state branch of the 4.2 MeV state of Ne^{20}. amma rays from the F^{19}(d, nγ) Ne^{20} reaction were observed with nergies of 11.4, 10.67, 9.37, 8.37 and 7.36 MeV.

539.16

13207

GAMMA-RAYS FROM A Po—O^{18} NEUTRON SOURCE.

É.M.Tsenter, A.G.Khabakhpashev and I.A.Pirkin.

h. eksper. teor. Fiz., Vol. 37, No. 4(10), 1133-4 (Oct., 1959). n Russian. English translation in: Soviet Physics—JETP (New ork), Vol. 37(10), No. 4, 806-7 (April, 1960).

The gamma-ray spectrum of a Po—O^{18} source was explored ith a single-crystal scintillation spectrometer and an n—γ and a —γ coincidence circuit.

S.J.St-Lorant

539.16

13208

TRANSITION PROBABILITIES BETWEEN ROTATIONAL STATES OF NON-AXIAL ODD NUCLEI.

Van Lin [Wang Ling].

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1153-5 (Oct., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 4, 821-2 (April, 1960).

Reduced probabilities for electric quadrupole and magnetic dipole transitions between various levels are computed. Of the E2 transitions the following ($\frac{3}{2}\,1 \rightarrow \frac{1}{2}$), ($\frac{5}{2}\,1 \rightarrow \frac{1}{2}$) and ($\frac{5}{2}\,3 \rightarrow \frac{3}{2}\,2$) have the greatest reduced probabilities. If the nuclear shape deviates strongly from axial symmetry the E2 transitions ($\frac{3}{2}\,2 \rightarrow \frac{3}{2}\,1$) and ($\frac{5}{2}\,2 \rightarrow \frac{5}{2}\,1$) also become pronounced and the M1 transitions ($\frac{5}{2}\,2 \rightarrow \frac{5}{2}\,1$) and ($\frac{5}{2}\,3 \rightarrow \frac{3}{2}\,2$) become important, otherwise all M1 transitions have small reduced probabilities. The results indicate that all magnetic transitions to the ground state should be very weak compared to the electric transitions.

E.A.Sanderson

539.16 : 539.2 : 538.27

HYPERFINE INTERACTIONS IN MAGNETIC MATERIALS BY γ—γ ANGULAR CORRELATION MEASUREMENTS.

See Abstr. 11883

539.16 : 539.17

CIRCULARLY POLARIZED GAMMA RAYS FROM DIRECT NUCLEAR REACTIONS.

See Abstr. 11397

539.16

13209

THE RELATIVE γ-TRANSITION PROBABILITIES IN STRONGLY DEFORMED NUCLEI.

A.V.Gnedich, L.N.Kryukova and V.V.Murav'eva.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 726-8 (March, 1960). In Russian.

The relative intensities of the γ-transitions in Lu^{175} and Hf^{177} were determined from the photoelectron spectra. The discrepancy between the experimental values of the relative γ-transition probabilities and the theoretical values derived by Alaga rules is confirmed. A similar discrepancy between the experimental and theoretical values is pointed out for the Yb^{173} and W^{183} nuclei.

539.16

13210

INVESTIGATION OF THE γ-SPECTRUM OF Ce^{140}.

S.F.Antonova, S.S.Vasilenko, M.G.Kaganskii and D.L.Kaminskii.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 765-7 (March, 1960). In Russian.

Gamma-radiation with energy above 2 mc^{2} from the Ce^{140} nuclide was investigated. For this purpose the internal-pair-conversion positron spectrum of decaying La^{140} was measured. By comparison of this spectrum with the corresponding K-shell electron conversion lines the multipolarities and intensities of γ-quanta with energies Eγ = 1596, 2330 and 2525 keV were determined. It is shown that for transitions involving energies above 2 mc^{2} such a method of determination of γ-quantum characteristics is advantageous in certain respects.

539.16

13211

LONG-LIVED LUTETIUM ISOTOPES.

V.A.Romanov, M.G.Iodko and V.V.Tuchkevich.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1019-26 (April, 1960). In Russian.

The conversion spectra of the long-lived lutetium isotopes Lu^{173} and Lu^{174} were investigated. The relative conversion line intensity in the soft region of the spectrum (up to 250 keV) was measured in the Lu^{173} spectrum. The ratio of the M1 + E2 mixture for 78.6 and 100.6 keV transitions was determined. Conversion lines were detected in the Lu^{174} spectrum which were ascribed to transitions connected with the isomeric state of Lu^{174} (E_{γ} = 44.7 keV M1 transition and E_{γ} = 59.0 keV M3 transition). The half-life of the isomeric state is ~ 90 days.

539.16

13212

INVESTIGATION OF THE RELATIVE INTENSITIES OF SOME CONVERSION LINES IN THE SPECTRUM OF NEUTRON-DEFICIENT LUTETIUM ISOTOPES.

M.G.Iodko, V.V.Tuchkevich, V.A.Romanov and O.M.Kresin.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1027-30 (April, 1960). In Russian.

A prism spectrometer was employed to investigate some of the more intense lines in the conversion spectrum of neutron-deficient Lu isotopes. The relative intensities and energies of the lines were determined and from the relation between the L-subshell intensities, the multipolarities of the corresponding γ-transitions are derived.

539.16

13213 INVESTIGATION OF THE DECAY SCHEME OF As^{76} BY THE $\gamma\gamma$-COINCIDENCE METHOD.

N.N.Delyagin and A.A.Sorokin.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1106-10 (April, 1960).
In Russian.

The decay scheme of As^{76} was investigated with a coincidence scintillation spectrometer. The following excited states of Se^{76} were found: 0.56, 1.21, 1.76, 2.42, 2.63 and ~ 2.85 MeV. Thirteen γ-transitions between these levels were detected and their relative intensities were determined.

539.16

13214 MEASUREMENT OF THE CIRCULAR POLARIZATION OF RESONANCE-SCATTERED GAMMA RAYS FOLLOWING THE ELECTRON CAPTURE OF Se^{75}.

F.Boehm and C.J.Gallagher, Jr.
Phys. Rev., Vol. 119, No. 1, 258-62 (July 1, 1960).

The circular polarization of the 265 keV γ-rays following the mixed Gamow—Teller and Fermi electron-capture decay of Se^{75} into As^{75} was measured. The neutrino momentum was fixed with the help of a resonance scattering process. From the experimentally determined degree of right-hand circular polarization of -0.21 ± 0.15 it was concluded that the sign of the Gamow—Teller to Fermi matrix-element ratio in this beta decay is negative.

539.16

13215 RESONANT SCATTERING OF GAMMA RAYS BY Ni^{60}.

N.A.Burgov, Yu.V.Terekhov and G.E.Bizina.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1612-13 (May, 1959).
In Russian. English translation in Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1146 (Nov., 1959).

Resonant scattering of 1.33 MeV γ-rays from a gaseous $Co^{60}Cl_2$ source by a nickel scatterer has been observed using a technique previously described (Abstr. 1820 of 1958). The angular distribution of the scattered quanta over the range 126° to 180° has been measured and agrees well with theoretical predictions. The lifetime of the first excited state of Ni^{60} was found to be $1.0 \pm 0.3 \times 10^{-13}$ sec in good agreement with other recent measurements. R.E.Meads

NUCLEAR REACTIONS

539.17

13216 THE TABULATION OF THREE FUNCTIONS ARISING IN NUCLEAR RESONANCE THEORY.

J.L.Cook and D.Elliott.
Austral. J. appl. Sci., Vol. 11, No. 1, 16-32 (March, 1960).

Tabulations to 5-D are given of three functions:

$$\psi(x,t) = \frac{1}{2\sqrt{(\pi t)}} \int_{-\infty}^{\infty} \frac{\exp[-(x-y)^2/4t]}{1+y^2} dy,$$

$$\phi(x,t) = \frac{1}{2\sqrt{(\pi t)}} \int_{-\infty}^{\infty} \frac{y \exp[-(x-y)^2/4t]}{1+y^2} dy,$$

and

$$\Psi_n(t) = \int_{-\infty}^{\infty} \psi^n(x,t) dx.$$

The values of both ψ and ϕ are given for $\zeta = 0(0.05)1$ and for $t = 0(0.025)0.2(0.05)1(0.1)2$, where $\zeta = x/(1+x)$. Values of $\Psi_n(t)$ are given for $n = 1(1)10$ and for $t = 0(0.025)0.2(0.05)1(0.1)2$.

539.17

13217 MONTE CARLO CALCULATIONS OF NUCLEAR EVAPORATION PROCESSES. IV. SPECTRA OF NEUTRONS AND CHARGED PARTICLES FROM NUCLEAR REACTIONS.

I.Dostrovsky, Z.Fraenkel and L.Winsberg.
Phys. Rev., Vol. 118. No. 3, 781-91 (May 1, 1960).

For Pt III, see Abstr. 1397 of 1960. The calculation of spectra of neutrons and charged particles and of cross-sections for their production from nuclear reactions is compared with experimental values. A compound-nucleus mechanism followed by nuclear evaporation is assumed for the reactions Zr, Ta, Bi(14.1 MeV n,n'); Ni(13.4–17.6 MeV n,p); Cu, Pd(23 MeV p,α); and Ni(162 MeV O^{16}, The production of neutrons and charged particles from the interac tion of 190 MeV protons with Ni, Ag, and Au is analysed in terms a nucleon cascade, followed by particle evaporation. The calculat of the nuclear evaporation is based on Wisskopf's statistical theor Fairly good agreement is obtained for the values of the cross-sec tions for producing these particles with an appropriate set of radi and level-density parameters in each case. There are serious di crepancies, however, in the comparison of the experimental and c culated spectra; many of the latter are deficient in low-energy neutrons and charged particles. Possible improvements in the calculation are discussed.

539.1

13218 MONTE CARLO CALCULATIONS OF NUCLEAR EVAPORATION PROCESSES. V. EMISSION OF PARTICLES HEAVIER THAN He^4.

I.Dostrovsky, Z.Fraenkel and P.Rabinowitz.
Phys. Rev., Vol. 118, No. 3, 891-3 (May 1, 1960).

Previous Monte Carlo calculations of nuclear evaporation re tions are extended to include the emission of He^6, Li^6, Li^7, Li^8, a Be^7 from Cu, Ag, Au, and Bi targets bombarded with high-energy protons (340-2000 MeV). Comparison with available experimenta results shows good agreement in most cases. A discrepancy has been observed between the calculated and observed variation of B formation cross-section with the mass of the target nucleus, but even here the agreement is within a factor of three. It is shown t for the usually chosen parameters of the calculation, a level dens parameter of a = A/10 is necessary.

539

13219 RECOIL STUDIES OF HEAVY ELEMENT NUCLEAR REACTIONS. I.

P.F.Donovan, B.G.Harvey and W.H.Wade.
Phys. Rev., Vol. 119, No. 1, 218-25 (July 1, 1960).

Techniques have been developed which permit the accurate measurement of angular distributions of recoil nuclei formed in nuclear reactions. The angular distributions of recoils from the reactions $Bi^{209}(\alpha,3n)At^{210}$, $Bi^{209}(\alpha,4n)At^{209}$ and $Bi^{209}(d,3n)Po^{208}$ are consistent with a reaction mechanism involving the formation of a compound nucleus and subsequent isotropic evaporation of the neutrons, as shown by comparison with Monte Carlo calculations based on an isotropic evaporation model.

539

13220 RECOIL STUDIES OF HEAVY ELEMENT NUCLEAR REACTIONS. II.

B.G.Harvey, W.H.Wade and P.F.Donovan.
Phys. Rev., Vol. 119, No. 1, 225-9 (July 1, 1960).

Angular distributions and ranges of recoils from the reactio $Bi^{209}(\alpha,2n)At^{211}$ and $Cm^{244}(\alpha,2n)Cf^{246}$ were measured. At helium i energies higher than about 10 MeV above the Q values of these reactions, the results are consistent with a reaction mechanism involving the emission of one or both neutrons in the forward hem sphere.

539

13221 TWO-NUCLEON STRIPPING PROCESS.

M.El Nadi.
Phys. Rev., Vol. 119, No. 1, 242-7 (July 1, 1960).

An expression is derived for the differential cross-section of processes in which two nucleons are captured from an incident α-particle or similar projectiles. The formula derived is compared with a similar one previously obtained together with some experimental data on the $P^{16}(d,\alpha)N^{14}$ reaction. Fairly good agreement is observed.

539

13222 DIRECT INTERACTION IN REACTIONS WITH EMISSION OF TWO NUCLEONS.

V.V.Komarov and A.M.Popova.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1574-6 (May, 1959).
In Russian. English translation in: Soviet Physics—JETP (New Y Vol. 36(9), No. 5, 1118-19 (Nov., 1959).

The momentum angular distribution of the c.m.s. of the two emitted nucleons was derived, assuming a plane wave-function fo incident nucleon and a shell model wave-function, in the L—S cou for the struck nucleon, using a rectangular potential well for the nucleon—nucleon interaction, and taking into account final state i actions outside the radius of the potential. Numerical results for the reaction $Be^9(n,2n)Be^8$ showed a peak at small angles which i ot seen experimentally. Allowance was made theoretically, for the fficulty in observing emulsion tracks in the forward direction when e recoil energy of the nucleus is less than 1 MeV and approximate greement with experiment is obtained. E.A.Sanderson

539.17

13223 BREAK-UP OF CHARGED PARTICLES BY A NUCLEAR COULOMB FIELD. M.Z.Maksimov.

h. eksper. teor. Fiz., Vol. 36, No. 5, 1582-3 (May, 1959). In ussian. English translation in: Soviet Physics— JETP (New York), ol. 36(9), No. 5, 1123-4 (Nov., 1959).

The problem of the dissociation of light nuclear particles by the oulomb field of a target nucleus is re-examined using classical ethods. Calculated values of the cross-section for such a process re in agreement with results obtained by other authors using quan- m-mechanical methods. The problem is of interest because such ffects can occur in ion sources with a high degree of ionization.

J.D.Dowell

539.17

13224 THE SCHWINGER EFFECT WITH A NUCLEUS SCREENED BY ATOMIC ELECTRONS. V.M.Koprov.

h. eksper. teor. Fiz., Vol. 38, No. 2, 639-41 (Feb., 1960). Russian.

A screened potential is used to calculate the change in the cattering cross-section of a heavy atom due to the Schwinger ffect. It is found that the screening only has an effect at very mall angles, the correction being 2.6% at $\theta = 20'$. Also it is shown at the Schwinger effect, in this case, vanishes for $\theta = 0^\circ$, which in direct contrast to the case with an unscreened potential, where e effect is infinite for $\theta = 0^\circ$. A.M.Green

539.17 : 539.14

NONLOCAL OPTICAL MODEL FOR NUCLEON—NUCLEAR NTERACTIONS. See Abstr. 13107

539.17

13225 REACTION Mg^{25} (p,γ) Al^{26}. J.C.Bizot, F.Muller and G.R.Bishop.

Phys. Radium, Vol. 19, No. 5, 571-2 (May, 1960). In French.

The excitation curve between 1 and 2 MeV shows 23 resonances e to the reaction. There is evidence for the level at 5.16 MeV in l^{26} indicated by Broude, Green, Willmott and Singh [Physica, Vol. 22, 39 (1956)], and for a level at 2.39 MeV whose properties are scussed. A.Ashmore

539.17

13226 NUCLEAR REACTIONS OF LOW-Z ELEMENTS WITH 5.7 BeV PROTONS. P.A.Benioff.

hys. Rev., Vol. 119, No. 1, 316-24 (July 1, 1960).

Describes the results of bombardments of Be, C, N, O, F, Na d Al. Production cross-sections were obtained for many radio- ctive products with half-lives between 1.2 min and 2.6 years. The , pn) cross-sections for the targets, C, N, O, F and Na were und to be 29 ± 3, 7.3 ± 0.7, 33 ± 5, 19 ± 2 and 31 ± 5 mb, respect- ely. Much of the variation in these values is thought to be due to e difference in the number of neutrons available for (p, pn) eactions in the different target nuclei. The cross-sections for her types of reactions studied do not change as much over the ove range of target elements as do the (p, pn) cross-sections. omparison of the cross-sections measured in this work with those tained at 0.98 to 3 BeV shows that in the 1 to 5.7 BeV energy range e excitation functions are nearly constant.

539.17 : 539.14

13227 NUCLEAR STRUCTURE AND SIMPLE NUCLEAR REACTIONS. P.A.Benioff.

hys. Rev., Vol. 119, No. 1, 324-47 (July 1, 1960).

Recently it has become increasingly evident that some assump- ons in the nuclear model used for Monte Carlo calculations yield ross-section values which are not in accord with experiment. In articular, calculations of (p, pn) reaction cross-sections in the eV energy range give values which are low by factors of 2-9 when ompared to experimental values. The calculated cross-sections lso show a smooth variation with the target atomic weight whereas e experimental values show quite an erratic variation. Reasons hich have been advanced to account for this lack of agreement are e lack of a nuclear surface and failure to account for shell effects the nuclear model used. In this work a theory is developed to ke account of surface and shell effects and thereby describe the bserved magnitude and variation of the cross-sections for simple nuclear reactions as exemplified by the (p, pn) reaction. At multi BeV energies, to which this treatment is restricted, the main contribution to the (p, pn) reaction cross-section comes from inelastic collisions between the incident protons and target neutrons, with all the p—n collision products escaping without further interaction. Approximations used include the impulse approximation, 0° lab. scattering angle for the inelastic p—n collision products, classical trajectories for the incident and scattered particles, and a quantum-mechanical treatment for the target nucleons. The multi BeV n—p, cloud-chamber data was used to determine the average total exit cross-section for the inelastically scattered particles. The only neutron shells in the target nucleus contributing to the (p, pn) reaction are those for which the instantaneous knocking out of a neutron creates a product-neutron hole state stable to particle emission. The combination of these assumptions gives integral expressions which, when evaluated on the IBM-701 computer for the independent particle harmonic-oscillator shell model, give the (p, pn) reaction cross-sections as a function of the nuclear density distribution and the number of available shells. For the low Z nuclei where the available shells can be unambiguously determined, the results give a half-central-density radius parameter, r_0, ($r_0 = R_{1/2}/A^{1/3}$), of about 1.2 fermis compared to 1.03 fermis for the charge half radius from the electron-scattering work. Use of reasonable limits on the value of r_0 allows one to set the minimum number of shells available for some targets. For example, the Zn^{64}, Cu^{65} and Cu^{63} (p, pn) cross-sections require that a large part of all the $1f_{7/2}$ neutrons be available, or, equivalently, that a $1f_{7/2}$ neutron hole state (across a major shell) in the product nucleus have less than 8 to 9 MeV excitation energy. The results also show that the energy associated with nuclear rearrangement to particle-stable product states must be less than 8 to 9 MeV. In several cases, the upper limit can be lowered considerably (to 1.5 MeV and 0 MeV in the cases of O^{16} and N^{14}, respectively).

539.17

13228 POLARIZATION OF PROTONS SCATTERED FROM C^{12}. T.A.Tombrello, R.Barloutaud and G.C.Phillips.

Phys. Rev., Vol. 119, No. 2, 761-6 (July 15, 1960).

The polarization of protons elastically scattered from carbon in the energy region between 4.65 and 5.0 MeV was measured by double scattering from carbon targets. These results, together with the findings at Harwell by Evans and Grace (unpublished), show that the polarizations predicted from the phase shift analysis are somewhat in error. This disagreement may be explained by making small changes in the splitting of the P- and D-wave phase shifts without seriously affecting the fit to the angular distributions. It was found that in the energy range from 3.0 to 4.0 MeV the D-wave phases required from 1° to 4° additional splitting, while in the range from 4.0 to 5.0 MeV the splitting of the P-wave phases had to be reduced by 4°. These modified phase shifts give a revised contour map of spin polarization versus energy and angle.

539.17

13229 INTERPRETATION OF THE RATIO OF EMISSION PROBABILITIES FOR PROTONS AND NEUTRONS. R.Nakasima and K.Kikuchi.

Progr. theor. Phys., Vol. 17, No. 6, 816-17 (June, 1957).

The ratio of (p, pn) to (p,2n) cross-sections for medium-weight nuclei bombarded by 21.5 MeV protons is unexpectedly large. A direct interaction calculation based on the Fermi gas model, including surface penetrability and volume absorption, is in strong disagreement with experiment. Surface interactions and deuteron pick-up effects are suggested to account for the discrepancy.

D.W.L.Sprung

539.17

13230 PRELIMINARY NOTE ON THE INDIRECT (p,t) PROCESS. H.Hagiwara and M.Tanifuji.

Progr. theor. Phys., Vol. 18, No. 3, 322-4 (Sept., 1957).

The contribution of two simple modes to the (p,t) cross-section are calculated. The successive pick-up mode, in which two neutrons are picked up in turn, gives a cross-section much smaller than the experimental value. The paired pick-up mode, in which the proton picks up a correlated pair of neutrons, appears to be the dominant one. Some numerical results are given. E.J.Squires

539.17

13231 INTERACTION BETWEEN 660 MeV PROTONS AND ATOMIC NUCLEI AND THE NUCLEAR INTERNAL MOMENTUM DISTRIBUTION OF NUCLEONS. L.S.Azhgirei, I.K.Vzorov, V.P.Zrelov, M.G.Meshcheryakov, B.S.Neganov,

R.M.Rÿndin and A.F.Shabudin.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1631-49 (June, 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1163-74 (Dec., 1959).

Reports an investigation of the angular distributions and (by magnetic analysis) the energy spectra of secondary particles (mainly protons with energies > ~ 60 MeV) emitted at angles of 7, 12.2, 18, 24, and 30° in reactions between 660 MeV protons and the nuclei of Be, C, Cu, and U. The differential cross-sections for the emission of such secondary charged particles increase with decreasing angle. In order of decreasing energy, the various spectral regions of all the investigated elements correspond respectively to diffractional scattering of protons on nuclei (in the small-angle region), single quasi-elastic nucleon collisions, π-meson production on bound nucleons, and intranuclear cascade. The experimental energy spectra for single quasi-elastic proton-nucleus scattering are compared with the spectra computed in the impulse approximation under various assumptions regarding the momentum distributions of the nucleons in the nuclei. The Be and C data are consistent with a Gaussian nucleon-momentum distribution with a 1/e value at an energy of approximately 20 MeV.

539.17

13232 POLARIZATION OF PROTONS IN SCATTERING BY C^{12}. S.A.Baldwin and V.I.Man'ko.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1937 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1377-8 (Dec., 1959).

A phase-shift analysis of the results of Reich et al. (Abstr. 2637 of 1957) for the elastic scattering of protons by C^{12} in the energy interval 1.5-5.5 MeV is used to obtain information about the spins and parities of the energy levels in N^{13}. The authors show that polarization measurements could considerably supplement the information which might be obtained about the levels of a given nucleus, by enabling a much more accurate phase-shift analysis to be performed. It is pointed out as a feature of the calculations that in the energy interval 2-5 MeV carbon could provide a very effective polarizer and analyser; this might prove to be more convenient than using He^4.
J.D.Dowell

539.17 : 539.14

PROTON INELASTIC SCATTERING FROM Si^{28}, Si^{29} AND Si^{30}. See Abstr. 13141

539.17

13233 INELASTIC INTERACTIONS OF 9 BeV PROTONS WITH FREE AND BOUND NUCLEONS IN AN EMULSION.
N.P.Bogachev, S.A.Bunyatov, Yu.P.Merekov, V.M.Sidorov and V.A.Yarba.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1346-8 (April, 1960). In Russian.

The angular and momentum distributions of secondary particles are described. These are based on 140 p—p and 103 p—n events, selected by the usual criteria. The mean numbers of secondary protons, π^+, π^- are given as 1.3 ± 0.3, 1.3 ± 0.3, 0.61 ± 0.6, respectively. In centre-of-mass system the mean momenta for protons and pions are 1.2 ± 0.1 and 0.4 ± 0.1 BeV/c. In the laboratory system, 36 ± 2% of the proton energy goes into pion production. These results differ from predictions of the statistical theory.
D.W.L.Sprung

539.17 : 539.12

NUCLEAR DISINTEGRATIONS PRODUCED BY 9 BeV PROTONS. See Abstr. 13042

539.17 : 539 12

PRODUCTION OF STRANGE PARTICLES IN THE INTERACTION BETWEEN 9 BeV PROTONS AND EMULSION NUCLEI. See Abstr. 13068

539.17

13234 FRAGMENT PRODUCTION BY 100 MeV PROTONS. U.R.Arifkhanov, M.M.Makarov, N.A.Perfilov and V.P.Shamov.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1115-22 (April, 1960). In Russian.

Formation of multicharged fragments of photographic emulsion nuclei by 100 MeV protons was investigated. The fragmentation cross-sections were (1.93 ± 0.64) mb for heavy emulsion nuclei and (1.16 ± 0.36) mb for light nuclei. Energy and angular characteristics of the process were obtained. Arguments are presented which support the hypothesis that multicharged fragments are produced at 100 MeV in quasi-elastic scattering on nucleons in the nuclei.

539.17 : 53

NEUTRON YIELDS PER INTERACTION IN U, Pb, W, AND S
BY 250-900 MeV PROTONS. See Abstr. 13098

539

13235 INELASTIC SCATTERING OF PROTONS AND DEUTERONS BY Mg^{24}. O.F.Nemets and G.A.Prokope
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 693-6 (March, 1960). In Russian.

The angular distribution of 6.8 MeV protons and 13.6 MeV
deuterons inelastically scattered by Mg^{24}, in which the 2^+, 1.37 M
level was excited, was investigated in the angular interval from 2
to 140°. Some new details of the angular distribution in the small
angle region were detected. Comparison with inelastic scatterin
theories shows that the direct-interaction mechanism is importa

539

13236 ELASTIC SCATTERING OF DEUTERONS BY HEAVY NUCLEI. Y.Nishida.
Progr. theor. Phys., Vol. 19, No. 4, 389-403 (April, 1958).

An analysis is made of the available data at 11 and 15.2 MeV
Because $Ze^2/\hbar v \gg 1$ and the reduced wavelength of the deuteron i
much shorter than the nuclear dimensions, the centre-of-mass
motion of the deuteron can be described by the classical approac
The wave mechanical description is applied only to the internal
motion of the deuteron. It is shown that for deuteron scattering a
11 MeV the departure from the Rutherford scattering can be com
pletely attributed to the electric breakup of the deuteron. The re
sult of the analysis of deuteron scattering at 15.2 MeV shows that
although at larger scattering angles the effect of the nuclear abso
tion due to the diffractional scattering of deuterons cannot be
neglected, the main contribution to the departure from the Ruther
scattering comes from the effect of the electric breakup of the
deuteron. The calculation of the cross-section of the electric bre
up by the semi-classical method of the virtual quanta modified fo
the non-relativistic case is performed to compare with the result
obtained from the analysis. The limitation of this method is also
discussed. In conclusion, it is emphasized that the mechanism of
the elastic scattering of deuterons by heavy nuclei is quite differe
from those of the elastic scattering of alpha-particles by nuclei a
of deuterons by light nuclei.

539.17 : 53

STUDIES OF LOW-LYING LEVELS OF EVEN—EVEN NUCL
WITH (d,p) AND (d,t) REACTIONS. See Abstr. 13140

53

13237 STRIPPING MECHANISM FOR REACTIONS WITH SMALL Q VALUE: THE REACTION $Li^7(d,p)Li^8$.
J.P.F.Sellschop.
Phys. Rev., Vol. 119, No. 1, 251-8 (July 1, 1960).

A number of angular distributions of protons from the reacti
$Li^7(d,p)Li^8$ were measured for a range of incident deuteron energ
below 2.5 MeV. These agree remarkably well with a simple forn
Butler—Born stripping theory, uncorrected for Coulomb and nucl
effects. A description is given for this unusual agreement in ter
of the small Q value, −0.188 MeV, for the reaction. A resonance
the proton yield is found at an incident deuteron energy of 1.4 Me
which has not been observed in measurements of the β yield fro
this reaction. Angular distributions measured on and around the
resonance show no influence of this on the unusually good strippi
patterns.

53

13238 RESULTS OF STRIPPING ANALYSIS OF THE $Co^{59}(d,p)Co^{60}$ REACTION.
H.A.Enge, D.L.Jarrell and C.C.Angleman.
Phys. Rev., Vol. 119, No. 2, 735-40 (July 15, 1960).

The MIT-ONR electrostatic generator and broad-range mag
netic spectrograph were used to investigate proton groups produ
by bombarding thin cobalt targets with 6.0 MeV deuterons. The a
lar distributions of the 28 most intense proton groups correspon
to as many levels in Co^{60} were analysed in terms of stripping the
to determine the orbital angular momentum of the captured neut
The Q values of the (d,p) reaction were measured for sixty level
of Co^{60}. The ground-state Q value was found to be 5.262 ± 0.011

53

13239 (d,p) AND (d,t) REACTIONS ON MAGNESIUM ISOTO
E.W.Hamburger and A.G.Blair.
Phys. Rev., Vol. 119, No. 2, 777-87 (July 15, 1960).

Natural and enriched magnesium targets were bombarded w

 MeV deuterons. The reaction products were analysed magneti-
y and detected in a scintillation counter. Angular distributions
n 10° to 60° (in some cases to 90°) were obtained for most of the
owing reactions: $Mg^{24}(d,p)$ to the 0, 1.61 and 1.96 MeV levels of Mg^{25},
$^{5}(d,t)$ to the 0, 1.37, 4.12, 4.24, 5.24, 6.01, 7.33, and 7.60 MeV
els of Mg^{24}, and $Mg^{26}(d,t)$ to the 0, 0.58, 0.98, 1.61, 1.96, 2.56,
, 2.80, 3.40, and 3.90 MeV levels of Mg^{25}. The level at 7.60 MeV
g^{24} has not been reported before. The observed angular distri-
ons are compared to stripping theory, and l values and absolute
ced widths are extracted. An anomaly in the angular distribu-
was found for the transitions between the Mg^{24} and Mg^{25} ground
es and was studied as a function of incident deuteron energy. The
ced widths obtained are compared to the predictions of the rota-
al model, and, in general, good agreement is found; however, an
ixture (of ≅ 15%) of higher rotational bands was found in the
^{6} ground-state wave function.

539.17 : 539.14

PROTON GROUPS FROM $P^{31}(d,p)P^{32}$: EXCITED STATES OF P^{32}.
Abstr. 13147

539.17

13240 ANGULAR DISTRIBUTIONS OF $B^{10}(d,\alpha)Be^{8}$ REACTIONS FROM 0.6 TO 1.5 MeV. R.L.Becker.
s. Rev., Vol. 119, No. 3, 1076-9 (Aug. 1, 1960).

Angular distributions of the two most energetic alpha-particle
ups resulting from deuteron bombardment of B^{10} were measured
even deuteron energies between 0.58 and 1.50 MeV. In addition
he usual pulse-height analysis of the detector output, pulse-decay
lysis was also employed so that alpha particles could be distin-
shed from protons giving the same pulse size. The shapes of the
ular distributions were not isotropic, the yield being slightly
er at back angles.

539.17

13241 EXCITATION CURVES AND ANGULAR DISTRIBUTIONS FOR $N^{14}(d,n)O^{15}$. T.Retz-Schmidt and J.L.Weil.
s. Rev., Vol. 119, No. 3, 1079-84 (Aug. 1, 1960).

Excitation curves for the highest energy neutron group in the
ction $N^{14}(d,n)O^{15}$ were measured at θ_{lab} = 0°, 30°, 90°, and 164°
deuteron bombarding energies between 0.66 and 5.62 MeV. A
se shape discrimination detector was used to eliminate the pulses
to γ-rays from the neutron spectra. There is considerable
onance structure in the excitation curves, with the anomalies
earing at different energies for the different angles. The
ular distribution of this neutron group was also measured at
nbarding energies of 0.91, 1.17, 1.51, 1.88, 2.58, 3.13, 3.56, 4.36,
0, and 5.27 MeV. The shape of the angular distribution changes
idly with energy at low bombarding energy, but above 3.5 MeV
shape becomes more stable. The maximum cross-section at
angle was 5.5 millibarns per steradian.

539.17

13242 THE POSSIBILITY OF APPEARANCE OF SECOND-ORDER PROCESSES IN INELASTIC SCATTERING OF
UTERONS BY NUCLEI.
.Edakova, V.G.Neudachin and E.A.Romanovskii.
eksper. teor. Fiz., Vol. 38, No. 1, 248-50 (Jan., 1960). In
ssian.

The simple theory of deuteron scattering in which either the
ton or neutron interacts at the nuclear surface fails to account
the low-angle peaks which are found in the experimental
ular distributions. A process in which a nucleon is first stripped
m the deuteron, and then picked up again, leaving the target
leus in an excited state is considered. By including both pro-
ses an excellent fit to the experimental data is obtained. The
endence of the position of the first peak on the incident deuteron
rgy is discussed. J.A.Evans

539.17

13243 POLARIZATION OF DEUTERONS ELASTICALLY SCATTERED ON ZERO-SPIN NUCLEI. G.M.Budyanskii.
eksper. teor. Fiz., Vol. 38, No. 4, 1170-5 (April, 1960).
Russian.

The most general form of the transition matrix is presented.
dependence of the transition-matrix parameters on experimen-
y observed quantities is established. The general and explicit
ressions for the double scattering cross-section and vector and
sor polarization are derived, which allow for mixing of different
es. Phase shifts, and hence a description of scattering, can be
ained by choosing a special form of the potential (such as that
ployed in the optical model). Calculations performed in the Born
roximation are compared with the experimental results.

539.17

13244 ELASTIC AND INELASTIC SCATTERING OF DEUTERONS ON Al AT 11.8 MeV.
A.Doehring, R.Jahr and U.Schmidt-Rohr.
Z. Phys., Vol. 159, No. 2, 149-54 (1960). In German.

Using the deuteron beam of a cyclotron, a study was made of the angular dependence of the deuteron spectrum from interactions on Al^{27}. Separation of the deuterons from other products of the reactions was accomplished by recording dE/dx (measured by a three channel proportional counter) and E (measured by a CsI-counter) on an oscilloscope screen. The experimental inelastic angular distributions have the shape of a direct interaction process. The elastic angular distribution shows pronounced diffraction maxima.

539.17

13245 THE ANGULAR DISTRIBUTION OF NEUTRONS FROM THE REACTION $C^{13}(\alpha,n)O^{16}$.
O.M.Mdivani and T.G.Gachechiladze.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1591-2 (May 1959). In Russian. English translation in Soviet Physics —JETP (New York), Vol. 36(9), No. 5, 1131 (Nov., 1959).

An analysis is performed of the results of Schiffer, Kraus and Risser (Abstr. 4707 of 1957) for the angular distribution of neutrons from this reaction at four α-particle energies (E_{α} = 2.69, 2.83, 4.42 and 4.63 MeV), in terms of a direct interaction. Two processes are considered: firstly, where the α-particle "knocks out" a neutron, in analogy with (p,n) reactions and secondly, where the C^{13} nucleus is stripped in the collision, in analogy with the (d,n) reaction. In the first process, the neutrons are emitted predominantly in the direction of the incident α-particles and in the second, in the opposite direction. Theoretical curves, including both processes, show reasonable agreement with the experimental results. J.D.Dowell

539.17

13246 ANGULAR DISTRIBUTION OF TRITONS FROM THE REACTION $Li^{7}(\alpha,t)Be^{8}$.
S.V.Starodubtsev and K.V.Makaryunas.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1594-5 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1133 (Nov., 1959).

Nuclear emulsions were used to investigate the angular distribution of tritons from this reaction (Q = -2.56 MeV), with α-particle energies of 8.34, 10.15, 11.5, 13.2 and 14.7 MeV. Similar angular distributions were obtained at all the energies. The form of the angular distributions and its weak dependence upon energy can be satisfactorily explained in terms of a direct interaction with angular momentum l = 1 transferred to the target nucleus at the time of collision. J.D.Dowell

539.17

13247 NOTE ON HEAVY ION INDUCED NUCLEAR REACTIONS. R.Nakasima.
Progr. theor. Phys., Vol. 19, No. 6, 743-5 (June, 1958).

The heavy-ion-induced nuclear reactions $Na^{23}(N^{14},\alpha p)P^{32}$ and $Na^{23}(N^{14},\alpha 2p)Si^{31}$ are analysed on a compound nucleus model, basing the calculation on a multiple evaporation process. These calculations lead to a value for the ratio $\sigma(P^{32})/\sigma(Si^{31})$ = 26.6, which is in good agreement with the experimental value of 22 ± 5. Using the experimental values $\sigma(P^{32})$ = 91 ± 18 mb and $\sigma(Si^{31})$ = 4.1 ± 0.8 mb, the cross-section for formation of the compound nucleus $\sigma_c^{(N)}$ at 26 MeV bombarding energy was calculated, yielding a value of 3 barns. This is unexpectedly high since a value of ~400 mb would be expected on conventional theory, the result being somewhat dependent on the choice of nuclear radius. Two possible reasons are suggested for this large discrepancy: (1) the effect of distortion in the nuclei concerned, and (2) the effect of difuseness of the nuclear surface, the latter being most likely in this instance. The experimental results for the angular distributions in the reactions show a forward peak in the α-particle yield and are difficult to explain by means of a compound nucleus model. R.E.Meads

539.17

13248 NUCLEAR REACTIONS INDUCED BY HEAVY IONS. Dzh.G.[J.H.] Fremlin and Dzh.S.Lille [J.S.Lilley].
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 324-6 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 229-30 (Jan., 1960).

A beam of nitrogen ions of mean energy 65 MeV and half-width 12 MeV was directed through a silver foil. Scattered protons and α-particles were recorded by C-2 emulsion in the angular range

45°-170°. Both protons and α-particle distributions indicated a strong forward peak, the former being about 3 times more numerous than the latter. Their mean energies at 90° were 8 and 15 MeV, both less than the potential barrier of the compound nucleus.

A.Ashmore

539.17 : 539.1.07

THE RANGE AND IONIZATION OF HEAVY IONS IN EMULSION. See Abstr. 12772

539.17 : 539.1.07

THE RANGE—ENERGY RELATIONSHIPS FOR SEVERAL IONS IN NUCLEAR EMULSIONS. See Abstr. 12771

539.17

13249 **INTERACTION OF ACCELERATED NITROGEN NUCLEI WITH BISMUTH.** V.A.Karnaukhov.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1933-5 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1375-6 (Dec., 1959).

Alpha-particle activity was measured in bismuth layers exposed to a 102 MeV beam of nitrogen ions. The resulting activities and their excitation functions are considered in terms of the types of reaction which can produce them.

A.Ashmore

539.17

13250 **GAMMA-RAYS ACCOMPANYING INTERACTION OF ACCELERATED C^{12} IONS WITH Sn NUCLEI.**

V.A.Karnaukhov and Yu.Ts. Oganesyan.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1339-40 (April, 1960). In Russian.

An experiment was carried out to test the suggestion of Strutinskii that the gamma-rays come from decay of a highly excited compound nucleus, of energy up to 66 MeV and angular momentum about 45 ħ. 78 MeV C^{12} ions were used, and γ-rays of 0.4 to 4.0 MeV were detected in a γ-spectrometer with 0.075 MeV channels. The gamma spectrum had a maximum at 0.8 MeV, compared with 2 MeV in a typical (n,γ) reaction. It is estimated that more than 10 gammas accompany each interaction on average.

D.W.L.Sprung

539.17 : 539.14

13251 **RESONANCES IN C^{12} ON CARBON REACTIONS.** A.Almqvist, D.A.Bromley and J.A.Kuehner.

Phys. Rev. Letters, Vol. 4, No. 10, 515-17 (May 15, 1960).

Yields of protons, neutrons α-particles, and γ-rays from the reaction of C^{12} on carbon were measured as functions of bombarding energy in the range 9-29 MeV. Three narrow resonances for all products were observed at centre-of-mass energies 5.68, 6.00, and 6.32 MeV, and there is evidence of other, less distinct, resonances at higher energies. No such resonances were observed with carbon—oxygen and oxygen—oxygen reactions. It is suggested that the two carbon nuclei form a quasi-molecular state. See also following two abstracts.

D.J.Thouless

539.17 : 539.14

13252 **"MOLECULAR" STATES FORMED BY TWO CARBON NUCLEI.** E.Vogt and H.McManus.

Phys. Rev. Letters, Vol. 4, No. 10, 518-20 (May 15, 1960).

It is shown that the positions and widths of the resonances observed by Almqvist, Bromley, and Kuehner (see preceding abstract) are in qualitative agreement with the existence of a "molecular" bound state of two carbon nuclei. The molecule is pictured as two deformed carbon nuclei joined by a narrow neck. The resonances might be due to vibrational and rotational excited states of such a molecule. Some detailed calculations are described. It is pointed out that O^{16} is not easy to deform, and so two O^{16} nuclei could not form such a bound system.

D.J.Thouless

539.17 : 539.14

13253 **GRAZING COLLISIONS OF COMPLEX NUCLEI.** R.H.Davis.

Phys. Rev. Letters, Vol. 4, No. 10, 521-2 (May 15, 1960).

The energy levels of a bound system of two carbon nuclei are calculated by assuming that the optical model potential gives the nuclear part of the interaction. The results are compared with the elastic scattering data in the region 6.5-15 MeV centre-of-mass energy. The detailed results differ markedly from those of Vogt and McManus (see preceding abstract), since they predict low-lying levels with high angular momentum.

D.J.Thouless

53

13254 **STRONG-COUPLING ESTIMATE OF THE EFFECTI
CROSS-SECTION FOR ELECTRONS SCATTERED B
ALKALI ELEMENTS.** R.Damburg and V.Kravchenko.

Latv. PSR Zinat. Akad. Vestis, No. 1(150), 73-6 (1960). In Russ

In a two-channel model, the total cross-section as a functio
energy is approximately evaluated. The method is a refinement
that proposed by Seaton (Abstr. 6252 of 1955). By including elas
scattering, which increases at low energies, fair agreement with
experiment is obtained.

D.W.L.Sp

53

13255 **SCATTERING OF ELECTRONS BY NUCLEI ACCORDING TO THE α-PARTICLE MODEL.**

E.V.Inopin and B.I.Tishchenko.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1160-6 (April, 1960). In Russian.

Elastic and inelastic (involving excitation of rotational level
scattering of high-energy electrons by Be^9, C^{12} and O^{16} nuclei is
sidered on the basis of the α-particle nuclear model. The calcu
differential cross-sections for elastic scattering on these nuclei
also inelastic scattering with excitation of the 2.43 MeV and 6.8
levels in the Be^9 nucleus and the 4.43 MeV level in the C^{12} nucle
are in good agreement with the experiments. It is also demonst
that elastic scattering on C^{12} with excitation of the 9.61 MeV leve
can be explained within the framework of the model, if one ascri
a spin and parity of 3^- to this level.

539.17 : 5

THE GIANT RESONANCE IN PHOTONUCLEAR REACTION
See Abstr. 13129

53

13256 **(γ,p) REACTION ON CADMIUM AND TIN.** M.Rozkoš, M.Smrčka and O.Jakubček.

Czech. J. Phys., Vol. 10, No. 2, 129-35 (1960). In Russian.

Discrete γ-rays of energy 17.6 and 14.8 MeV were used. O
going protons were registered in five nuclear emulsion plates, e
covering a certain angular interval. The energy spectrum for th
closed shell nucleus Sn agrees with Wilkinson's theory of the gia
resonance, but for Cd the spectrum is similar to evaporation the
The angular distributions agree with neither theory. With both
elements there are both single particle and collective features i
results.

D.W.L.Sp

53

13257 **THE PHOTODISINTEGRATION OF THE NUCLEUS** A.P.Komar, Ya.Krzhemenek and I.P.Yavor.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 2, 283-5 (March 11, 1960). In Russian.

The photodisintegration was investigated using a Wilson clo
chamber filled with a nitrogen and helium gaseous mixture whic
facilitates identification and measurements. The threshold ene
and percentage ratios of the various decays were determined.
total cross-section for γ-quanta absorption was found to be
9.8 ± 0.8 mb/Q and the value, 0.3 MeV barn, obtained for the to
integrated absorption cross-section shows good agreement with
theory. The energy spectra of the photoprotons and the angular
tributions of the emitted protons and neutrons are given for the
reactions (γ,p) and (γ,np). The integrated cross-section for the
reaction was found to be 0.07 MeV barn, and an analysis, on the
basis of the Wilkinson model, indicates that the overwhelming p
of the reaction occurs by a direct resonance process. An analy
of the (γ,np) results is also made and it is suggested that in abo
two-thirds of the cases the neutron is emitted initially with a re
tively large energy, as a result of a direct resonance process,
then the proton emerges from the weakly excited nucleus N^{13}. T
contribution of protons from "quasi-deuteron" mechanisms to th
decay of protons having energies greater than 18 MeV is estim
at ~ 1%.

E.A.Sande

5

13258 **THE MECHANISM OF THE REACTION $^{16}O(\gamma,4\,\alpha)$.** B.Čujec-Dobovišek.

"J. Stefan" Inst. Rep., Vol. 3, 61-77 (Oct., 1956).

The mechanism of the reaction $O^{16}(\gamma, 4\,\alpha)$ has been investi
on the basis of 142 stars induced in nuclear emulsions by the br
strahlung of maximum energy 32 MeV. A distinct change in the
mechanism with the photon energy of about 24 MeV has been ob
At $E_\gamma < 24$ MeV the reaction proceeds in about half the cases vi
9.6 and 10.8 MeV levels of C^{12}, and via ground-level of Be^8. F
remaining half of the cases it has not been possible to determi

chanism uniformly. That the reaction proceeds via the 12.76 MeV el of C^{12}, and the 3 MeV level of Be^8, is an acceptable interpreta- , but a direct disintegration into four alphas is possible as well. $E_\gamma > 24$ MeV, the reaction proceeds by 80-90% via the 16.1 MeV el of C^{12}, and the 3 MeV level of Be^8, whereas the remaining 10- involves a Be^8 ground-state nucleus. Angular distributions and relations in the transitions to the 16.1 MeV level of C^{12}, and the eV level of Be^8 have been determined, and partially compared h the theoretical ones. The change in the mechanism at $E_\gamma =$ 24 MeV is interpreted according to the isotopic spin selection es.

539.17

13259 SCATTERING OF Cs^{137} GAMMA-RAYS IN LEAD.

Ya.Alksnis and U.Ulmanis.

v. PSR Zinat. Akad. Vestis, No.3(152), 71-6 (1960). In Russian.

662 keV gamma-rays were scattered from lead. The energy and ular distributions were measured. The angular distribution of fluorescence X-rays at 78 keV was studied for various target cknesses and angles of incidence onto the flat target.

D.W.L.Sprung

539.17

13260 DEPENDENCE ON ATOMIC NUMBER OF THE NUCLEAR PHOTOEFFECT AT HIGH ENERGIES.

.Stein, A.C.Odian, A.Wattenberg and R.Weinstein.

ys. Rev., Vol. 119, No. 1, 348-51 (July 1, 1960).

A measurement was made of the number of neutron—proton ncidences observed when 320 MeV bremsstrahlung bombarded Li, Be, C, O, Al, Ti, Cu, Sn and Pb. If one normalizes the data the number if neutron—proton pairs in a nucleus (i.e., by iding by NZ/A) it is found that the observed coincidences decrease A increases. It is possible to account quantitatively for this A endence by correcting for the probability that two nucleons will ape from inside a nucleus without either having a collision. The bability of escape is a function of the nuclear radius, R and the an free path, λ, in nuclear matter. For medium weight elements observed neutron—proton pairs are produced with a cross- tion given by

$$\sigma_{Z,A}(\text{coincidences}) \cong 3.0(NZ/A)\,\sigma_D P(2R/\lambda),$$

ere σ_D is the cross-section for the photodisintegration of the teron and where $P(2R/\lambda)$ is the probability-of-escape factor. For nucleons emitted at 180°, the form of $P(x)$ is

$$P(x) = (3/x^3)[2-e^{-x}(x^2+2x+2)]$$

formula for the cross-sections is shown to be what one would ect if the fundamental mechanism in complex nuclei is the same hat suggested by Wilson for the photodisintegration of the deuteron constant, 3.0, depends on the cube of a neutron—proton pair raction distance. A less naive treatment also involves a nucleon r correlation function.

539.17

13261 PHOTONEUTRON REACTIONS: C^{12}, N^{14}, O^{16}, and F^{19} NEAR THRESHOLD.

.Geller, J.Halpern and E.G.Muirhead.

s Rev., Vol. 119, No. 2, 716-20 (July 15, 1960).

The reactions were studied with improved efficiency for the de- tion of the residual activity. The betatron energy calibration used ased on thresholds of deuterium, bismuth, copper and for scat- ing from the 15.12 MeV level in carbon. Results show that the esholds for nitrogen and fluorine correspond well with the expected ues for the respective neutron separation energies. For oxygen, position of threshold is also in good agreement. Assuming a ear extrapolation of the betatron calibration above 15 MeV, it is nd that the carbon threshold is 52 keV above the accepted value he separation energy. The successful correlation between the ignment of known resonance energies with the positions of many he breaks in the yield curves corroborates the assumed linearity he betatron energy scale above 15 MeV. It follows that previous atron calibrations using the carbon threshold must be in error by roximately 100 keV at 18.7 MeV.

539.17

13262 PHOTOPROTON AND PHOTONEUTRON PRODUCTION IN ALUMINUM AND COPPER.

.Chrien and A.H.Benade.

s. Rev., Vol. 119, No. 2, 748-54 (July 15, 1960).

The ratio of proton to neutron yields from Al and Cu irradiated with betatron X-rays up to 20.8 MeV in energy was measured. Simultaneous detection of protons and neutrons is accomplished by placing two samples of the same element in series in the X-ray beam. Direct detection methods are used in each case, a shallow proportional counter for protons and a boron-lined detector for neutrons. A photon difference method was used to reduce yield data to cross-section form. The proton and neutron yields for aluminium are found to be approximately equal at 20 MeV, with cross-sections of 19 and 21 mb, respectively. At 20.8 MeV a yield ratio of one proton to about 6 neutrons is found for copper, with a peak photoproton cross-section of 23 mb. The results are compared with a calculation based on the assumption that these reactions proceed through the formation of a compound nucleus.

539.17

13263 PHOTOPROTONS FROM Cu^{65}.

N.V.Linkova, R.M.Osokina, B.S.Ratner, R.Sh.Amirov and V.V.Akindinov.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 780-9 (March, 1960). In Russian.

The energy and angular distributions of photoprotons produced in a Cu^{65}-enriched sample by bremsstrahlung with peak energies $E_{\gamma\max} = 17.9$, 20, 24.5 and 28.5 MeV were studied with photographic emulsions. The dependence of the Cu^{65} photoproton yield on $E_{\gamma\max}$ was measured and the excitation curve for reactions involving the emission of a proton was determined. An analysis of the experimental data shows that a greater part of the proton yield is due to a mechanism which differs from that of evaporation. If this mechanism is assumed to be a direct photoeffect in which all the γ-quantum energy minus the binding energy is imparted to the ejected proton, one finds from the energy distributions that only a small part of the protons is due to a photoeffect from the upper level, the main contribution being due to transitions from lower shells. Two maxima at proton energies of $E_p \sim 4.7$ MeV and ~ 6.0 MeV were observed in the emitted particle spectrum. The angular distributions are described by a function of the form $a + b\sin^2\theta$ for $E_{\gamma\max} = 17.9$ and 20.0 MeV and of the form $a + b\sin^2\theta + c\sin^2\theta.\cos^2\theta$ for $E_{\gamma\max} = 24.5$ MeV and 28.5 MeV. This means that for $E_\gamma < 20$ MeV absorption of γ-quanta is of a dipole nature whereas at larger energies quadrupole absorption becomes appreciable.

539.17

13264 HIGH-ENERGY PHOTONUCLEAR DEUTERONS AND TRITONS. V.P.Chizhov.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 809-18 (March, 1960). In Russian.

The ratio of the (γ,d) cross-sections to the (γ,p) cross-sections for 15.5 - 30 MeV protons and deuterons produced by $E_{\gamma\max} = 90$ MeV bremsstrahlung is presented as a function of the nuclear mass number A for fourteen elements lying between Li^6 and Au. For immediate and heavy nuclei $\sigma(\gamma,d)/\sigma(\gamma,p) \sim A^{5/3}/Z$, which agrees with the concept of capture production of photodeuterons. The energy dependences of $\sigma(\gamma,d)/\sigma(\gamma,p)$ for Li^6 and Li^7 and also the energy distributions of photodeuterons from Li^6 and Li^7 and of phototritons from Li^7 are presented. A relatively large yield of high-energy phototritons from Li^6, Li^7 and B was observed. The angular distributions of photoprotons and photodeuterons from Li^6, Li^7, Be and C are compared. The shape of the experimental photodeuteron angular distributions is found to agree with those computed on the assumption that photodeuterons are produced as a result of capture. The angular distributions of high-energy phototritons from Li^6, Li^7 and Be are also presented.

539.17

13265 THE $Al^{27} \rightarrow Na^{24}$, $Co^{59} \rightarrow Mn^{56}$ AND $P^{31} \rightarrow Na^{24}$ REACTIONS UP TO 260 MeV γ-QUANTUM ENERGY RANGE.

A.A.Gorbunov, F.P.Denisov, and V.A.Kolotukhin.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1084-7 (April, 1960). In Russian.

Measurements were made of the yield of several photonuclear reactions as a function of the peak bremsstrahlung energy from a synchrotron, using the induced radioactivity method. The differential cross-sections were computed from the yield curves by the "photon difference" method. The shape of the energy dependence of the effective cross-sections indicates that, at photon energies above 60-80 MeV, photonuclear reactions proceed mainly without formation of an intermediate nucleus.

539.17

13266 RADIATIVE CAPTURE OF THERMAL NEUTRONS ON NUCLEUS. II.

J.Kopecký, J.Kajfosz and J.Urbanec.

Czech. J. Phys., Vol. 10, No. 2, 119-28 (1960). In Russian.

For Pt I, see Abstr. 4124 of 1960. The energies and intensities of gamma rays from the capture of a neutron on Na, Co, Zn, Ag, Te and I nucleus in the 20-1000 keV energy region were measured with a single-crystal, single-channel scintillation spectrometer. New radiative transition energies were measured when studying Co, Zn, Te and I nuclei.

539.17 : 539.1.07

A STUDY OF $C^{12}(n,\alpha)Be^{9}$ IN DIAMOND-LOADED EMULSIONS. See Abstr. 12791

539.17

13267 MEASUREMENTS OF THE $^{238}U(n,2n)^{237}U$ CROSS-SECTION. L.F.Sherman.

J. nuclear Energy, Vol. 9, No. 1-4, 113-14 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 87 (1958).

Natural uranium specimens were irradiated in a flux of 10^{12} to 10^{11} neutrons cm^{-2} sec^{-1} in the core of a fast reactor and the uranium was then separated from the fission products. The $U^{238}(n,2n)U^{237}$ cross-section was determined as 11.24 ± 1.7 millibarns by measuring the absolute number of U^{237} β-decays in a 4π-counter. After allowance for the known difference in the neutron spectrum at the point of irradiation and the fission spectrum, a value of 17 ± 3 millibarns was obtained for fission neutrons. S.E.Hunt

539.17

13268 EFFECT OF GEOMETRY ON RESONANCE NEUTRON ABSORPTION IN URANIUM. L.Dresner.

Nuclear Sci. Engng, Vol. 1, No. 6, 501-10 (Dec., 1956).

A simple theoretical expression has been derived for the geometric dependence of the effective resonance integral of uranium which is independent of the details of resonance structure. Comparison with experiment yields good agreement when the surface absorption is arbitrarily reduced to 60% of the theoretical value.

539.17

13269 MULTIPLE NEUTRON INTERACTIONS IN RESONANT FOILS. J.E.Draper.

Nuclear Sci. Engng, Vol. 1, No. 6, 522-40 (Dec., 1956).

Experiments on resonance neutron capture, scatter, or fission are often analysed with thin-foil approximations, but for reasons of intensity are better performed with foils of intermediate thickness. For aid in analysing the resulting corrections, the probability is calculated that a neutron at normal incidence on a foil will be scattered and undergo a second interaction in the foil. This probability if averaged over a resonance and is compared to the probability of a first interaction. The extension to multiple interactions is considered. An important effect is the change in cross-section because of energy loss in elastic scattering. The Doppler broadening of resonances and the effect of potential scattering are also included. The application to the area analysis of self-indication experiments is emphasized. This general case includes several more restricted cases with resonant detectors and with nonresonant detectors.

539.17

13270 STATISTICAL EVALUATION OF FISSION-PRODUCT ABSORPTION CROSS SECTIONS AT INTERMEDIATE AND HIGH ENERGIES. P.Greebler, H.Hurwitz, Jr. and M.L.Storm.

Nuclear Sci. Engng, Vol. 2, No. 3, 334-51 (May, 1957).

The use of the statistical properties of nuclear resonances to calculate fission-product poisoning in the intermediate energy range is described. On the basis of the available theoretical and experimental information, estimates of the average fission-product cross-section as a function of energy are given for the energy range 10^{2} to 10^{6} eV. Comparison is made with direct experimental measurements of intermediate energy absorption cross-sections for several isotopes. Because of the unusually large level spacings for target nuclei which have even proton and neutron numbers or near-magic neutron numbers, the average fission-product cross-sections obtained here are lower than those obtained in estimates which ignore this effect. The influence of various assumed statistical distributions of reduced neutron widths on the average cross-section is discussed.

539.17

13271 ON THE EFFECTIVE CAPTURE CROSS SECTION OF Pu-240 FOR REACTOR NEUTRONS.

R.W.Stoughton and J.Halperin.

Nuclear Sci. Engng, Vol. 2, No. 4, 481-7 (July, 1957).

Effective reactor capture cross section values for Pu^{240} were calculated both from experimental plutonium isotopic ratios and from the resonance parameters for the 1 eV resonance. Both methods gave values of about 1200 barns for highly dilute Pu as contrasted to values of about 500 barns which have been reported for re-irradiated Pu samples. The 1200 barn figure is consisten with a 2200 m/sec cross section of about 340 barns and a resona integral of about 8300 barns.

539

13272 THE INTERACTION OF 0.15 TO 1.0 MeV NEUTRONS WITH U-238, U-235 AND Pu-239. R.C.Allen.

Nuclear Sci. Engng, Vol. 2, No. 6, 787-93 (Nov., 1957).

The differential elastic scattering, total elastic scattering, a elastic transport cross-sections for U^{238}, U^{235}, and Pu^{239} for 0.5 a 1.0 MeV neutrons are presented. The nonelastic reaction cross-sections are given for these three materials for neutron energies 0.25, 0.5, and 1.0 MeV and in addition for U^{238} for 0.15 MeV neutr The inelastic scattering cross-sections for the excitation of the t lowest levels in U^{238} are also presented for neutron energies of 0.15, 0.25 and 0.5 MeV.

539.17 : 539

EFFECTS OF 14 MeV NEUTRON BOMBARDMENT OF U^{235} AND U^{238}. See Abstr. 11181

539

13273 THE PRODUCTION OF N^{16} AND N^{17} IN THE COOLIN WATER OF THE NRX REACTOR.

W.J.Henderson and P.R.Tunnicliffe.

Nuclear Sci. Engng, Vol. 3, No. 2, 145-50 (Feb., 1958).

Measurements have been made of the fast neutron cross-sections for the production of N^{16} and N^{17} in the uranium rod cool water of the NRX reactor by the reactions $O^{16}(np)N^{16}$ and $O^{17}(np)N$ The N^{16} and N^{17} were detected by their gamma and fast neutron activities, respectively, in a continuously flowing sample of the effluent water from a uranium rod. The cross-sections (fission neutron spectrum) for the reactions $O^{16}(np)N^{16}$ and $O^{17}(np)N^{17}$ are $1.85 \pm 0.15 \times 10^{-2}$ millibarns and $9.3 \pm 0.9 \times 10^{-3}$ millibarns, respectively.

539

13274 THE EFFECTIVE RESONANCE INTEGRAL OF THORIUM AND THORIUM OXIDE.

I.E.Dayton and W.G.Pettus.

Nuclear Sci. Engng, Vol. 3, No. 3, 286-95 (March, 1958).

The effective resonance integral has been measured for thor metal rods and plates and for ThO_2 rods of two different densitie Measurements were carried out in a cadmium tube in the centre a swimming-pool type research reactor using conventional "dang coefficient" techniques. Absolute calibration was obtained by the use of boron samples.

53

13275 SPATIAL DISTRIBUTION OF U^{238} RESONANCE NEUTRON CAPTURE IN URANIUM METAL RODS.

D.Klein, W.Baer and G.G.Smith.

Nuclear Sci. Engng, Vol. 3, No. 6, 698-706 (June, 1958).

The spatial distribution for resonance neutron capture in U has been determined within a 1.3% enriched uranium metal rod c 0.387 in. diameter. The resonance integral can be obtained fron this distribution.

53

13276 EQUILIBRIUM SPECTRUM AND DIFFUSION LENGT IN NATURAL URANIUM.

D.Meneghetti, H.H.Hummel and W.B.Loewenstein.

Nuclear Sci. Engng, Vol. 3, No. 6, 772-3 (June, 1958).

Neutron inelastic scattering excitation cross-sections for th low-lying levels of U^{238} reported by Cranberg and Levin are at c siderably variation with those inferred by the authors from previously available data, but are in better agreement with what is pected on theoretical grounds. It is suggested that the value of C barns for the cross-section of the reaction $U^{238}(n,\gamma)$ is too high, measured(Zephyr) value being 0.21 barns.

53

13277 URANIUM-235 NEUTRON CROSS SECTIONS FROM BREIT-WIGNER ANALYSIS. D.L.Kavanagh.

Nuclear Sci. Engng, Vol. 4, No. 2, 155-65 (Aug., 1958).

An analysis of the U^{235} resonance region by the use of Breit-Wigner formulae was carried out. The comparison of these res with experiment, where possible, shows quite good agreement ar makes it appear reasonable that this kind of analysis will yield usable values of σ_a, σ_f, σ_s in the resonance region.

539.17

13278

PRODUCTION CROSS SECTION OF N^{16} AND N^{17}.

P.A.Roys and K.Shure.

clear Sci. Engng, Vol. 4, No. 4, 536-45 (Oct., 1958).

The gamma-ray dose rate and the fast neutron flux have been easured in air from a source of water shortly after irradiation in e Materials Testing Reactor. Gamma rays from N^{16} and neutrons m N^{17} have been detected. From the measurements and the known ometry, the cross-sections for the $O^{16}(n,p)N^{16}$ and the $O^{17}(n,p)N^{17}$ actions averaged over the fission neutron spectrum have been duced to be 0.019 mb and 0.0052 mb, respectively. The results e compared with other measured values and theoretical estimates.

539.17

13279

TOTAL NEUTRON CROSS SECTIONS FOR STRUCTURAL MATERIALS.

R.J.Brown and L.M.Bollinger.

clear Sci. Engng, Vol. 4, No. 4, 576-80 (Oct., 1958).

The total neutron cross-sections of several structural materials ve been measured over the thermal range of energy. A plate of nmercial wrought nickel, thin sheets of 61S aluminium and a inder of 2S aluminium of 3 in.diameter were studied. The results the measurements are compared with previous results and the served differences are interpreted in terms of crystal structure.

539.17

13280

SOME REFINEMENTS IN THE CALCULATION OF RESONANCE INTEGRALS.

J.Chernick and R.Vernon.

clear Sci. Engng, Vol. 4, No. 5, 649-72 (Nov., 1958).

Two basic formulae for resonance absorption applicable both mixtures and to lumps are considered, the narrow resonance (NR) proximation and the infinite mass (NRIA) approximation. The rmulae are shown to be complementary, yielding accurate results en the choice between them is based on the practical width of e resonance line as originally suggested by Wigner. The formulae e used to calculate resonance integrals for U^{238} and Th^{232}. The sults yield a low mass absorption term and a surface absorption m proportional to the square root of the surface-to-mass ratio lumps of practical size in qualitative agreement with the perimental work of Egiazarov and Hellstrand for U^{238} and with yton and Pettus for thorium. Dresner's suggestion that the ratio the resonance integral to the mass absorption term is independent the resonance structure is not borne out. Refinement of the basic rmulae is discussed. The correction of the NRIA formula for ergy degradation is in agreement with Spinney's calculations for -H mixtures and with Monte Carlo results obtained by Auerbach for anium—water lattices. Consideration of lumping effects indicates t the basic formulae generally under-estimate the resonance sorption. It is therefore recommended that the common use of -defined flux disadvantage factors be dropped.

539.17

13281

CAPTURE AND FISSION PATTERNS OF U^{238} IN EBR-I (MARK II).

P.Kafalas and R.R.Heinrich.

clear Sci. Engng, Vol. 4, No. 5, 698-702 (Nov., 1958).

The capture and fission probabilities of U^{238} have been deter-ned radio-chemically as functions of horizontal position in EBR-I ark II). The ratios $\sigma_c(U^{238})/\sigma_f(U^{235})$ and $\sigma_c(U^{238})/\sigma_f(Pu^{239})$ are also esented as functions of horizontal position in the reactor.

539.17

13282

THE WIDTH OF THE 1 eV RESONANCE IN PLUTONIUM-240.

R.Leonard, Jr, E.J.Seppi and W.J.Friesen.

clear Sci. Engng, Vol. 5, No. 1, 32-5 (Jan., 1959).

The total neutron cross-section of Pu^{240} has been measured at e 1 eV resonance using a crystal spectrometer with good resolu-n. A detailed analysis was made of the shape of the resonance obtain the Breit—Wigner level width parameter. The level width s determined to be (32.3 ± 1.5) mV, and the resonance energy was 056 ± 0.003) eV.

539.17

13283

EFFECT OF (n,2n) AND (n,α) REACTIONS ON AGE CALCULATIONS FOR BERYLLIUM.

Meneghetti and H.H.Hummel.

clear Sci. Engng, Vol. 6, No. 1, 57-62 (July, 1959).

The effect of incorporating the (n,2n) and (n,α) reactions into rmi age calculations for beryllium has been studied. If one glects these effects an age to 1.44 eV of 85 cm^2 is computed, cluding a first-flight correction of 4 cm^2, as compared to the perimental value of 80 ± 2. Inclusion of (n,2n) and (n,α) reactions wers the calculated age to 71 cm^2.

539.17

13284

HEAVY NUCLIDE CROSS SECTIONS OF PARTICULAR INTEREST TO THERMAL REACTOR OPERATION: CONVENTIONS, MEASUREMENTS AND PREFERRED VALUES.

R.W.Stoughton and J.Halperin.

Nuclear Sci. Engng, Vol. 6, No. 2, 100-18 (Aug., 1959).

The various conventions and definitions of thermal and resonance flux are discussed. Measurements of the thermal neutron cross sections, resonance integrals, and reactor cross sections of the following nuclides are critically reviewed: Th^{232}, Th^{233}, Pa^{233}, U^{233}, U^{234}, U^{235}, U^{236}, U^{238}, U^{239}, Np^{239}, Pu^{239}, Pu^{240}, Pu^{241}, and Pu^{242}.

539.17

13285

SPECTRA OF γ-RAYS FROM NEUTRON CAPTURE BY HEAVY NUCLEI. I.

L.V.Groshev, A.M.Demidov and V.I.Pelekhov.

Nuclear Phys., Vol. 16, No. 4, 645-56 (June (1), 1960).

Comparison is drawn between the experimentally measured and calculated γ-spectra from the thermal-neutron reaction (n, γ) for the two forms of energy dependence of the level density $\rho(u) = p_0 e^{u/\tau}$ and $\rho(u) = p_0 e^{\sqrt{au}}$, where τ and a are constants. The effect of the energy gap in the level density of even—even nuclei on the spectrum of γ-rays in the range 0.8 to 4 MeV is discussed. The energy gap results in an essential difference between the spectra of odd—odd nuclei and those of even—even nuclei.

539.17

13286

SPECTRA OF γ-RAYS FROM NEUTRON CAPTURE BY HEAVY NUCLEI. II.

V.M.Strutinski, L.V.Groshev and M.K.Akimova.

Nuclear Phys., Vol. 16, No. 4, 657-73 (June (1), 1960).

The spectra of γ-rays accompanying thermal-neutron capture are calculated for dipole γ-radiation for two variants of the dependence of nuclear level density on energy. Parameters for the formula of nuclear level density are determined from comparison with experimental spectra. The results thus obtained for nuclear level density are compared with the data derived from other experiments.

539.17

13287

DEPENDENCE OF THE In^{116} ACTIVATION RATIO ON NEUTRON ENERGY.

F.Domanic and V.L.Sailor.

Phys. Rev., Vol. 119, No. 1, 208-12 (July 1, 1960).

Indium was irradiated with monochromatic neutrons of various energies, and a measurement was made of the ratio of the 54 min to the 13 sec activities of In^{116} produced by neutron capture in In^{115}. Such a ratio expresses the relative probability for populating the ground or the isomeric state from the initial compound state. The irradiations were made with monochromatic neutrons from a crystal spectrometer at the resonance energies 1.456 and 3.86 eV, in regions between resonances at 0.1 and 2.66 eV, and with "pile neutrons". The results show that the activation ratio differs for the two resonances by a factor of approximately 3.5, with relatively more of the 13 sec activity being associated with the 3.86 eV resonance. The half-lives of the two In^{116} activities were redetermined and the values 13.4 ± 0.4 sec and 53.9 ± 0.2 min were obtained.

539.17

13288

EXCITATION FUNCTION FOR $Zn^{64}(n,2n)Zn^{63}$.

D.R.Koehler and W.L.Alford.

Phys. Rev., Vol. 119, No. 1, 311-12 (July 1, 1960).

The excitation function was measured for neutron energies from 12.2 to 18.1 MeV by an activation method. An absolute cross-section was obtained by using the previously measured value (Rayburn, 1959) of 167 ± 11 mb at 14.4 MeV. Above threshold, the cross-section is found to increase rapidly with neutron energy, reaching a value of 337 mb at 18.1 MeV. A cross-section curve computed on the basis of statistical theory is shown for comparison.

539.17

13289

THE CROSS-SECTIONS FOR SOME NUCLEAR REACTIONS INDUCED BY 14 MeV NEUTRONS IN NaI:Tl, KI:Tl, CsI:Tl AND Li^6I:Eu SCINTILLATOR CRYSTALS.

M.Bormann, H.Jeremie, G.Andersson-Lindström, H.Neuert and H.Pollehn.

Z. Naturforsch., Vol. 15a, No. 3, 200-10 (March, 1960). In German.

The high detection efficiency of self-induced reactions in scintillator crystals is made use of to determine the cross-sections for some reactions initiated by 14 MeV neutrons. The activation method gave: $\sigma_{n,p}(I^{127}) = 25 \pm 15$ mb (measured relative to the $\sigma_{n,2n}(I^{127}) = 1.2$ b), $\sigma_{n,p}(Na^{23}) = 9 \pm 4$ mb, $\sigma_{n,\alpha}(Na^{23}) = 29 \pm 9$ mb, $\sigma_{n,\alpha}(K^{41}) = 12 \pm 5$ mb. Absolute cross-sections were obtained from coincidence measurements of the products of D(T,α)n reactions. The pulse-height methods yield:

$$\begin{aligned}
\sigma_{n,p}(Cs^{133} + I^{127}) &= 34 \pm 5 \text{ mb},\\
\sigma_{n,np}(Cs^{133} + I^{127}) &= 6 \pm 1 \text{ mb},\\
\sigma_{n,p}(K^{39}) &= 354 \pm 54 \text{ mb},\\
\sigma_{n,\alpha}(K^{39}) &= 110 \pm 16 \text{ mb},\\
\sigma_{n,np}(K^{39}) &= 186 \pm 28 \text{ mb}.
\end{aligned}$$

From the energy distribution of the protons the nuclear temperature of (n,p) and (n,np) processes was calculated using the statistical model.

S.J.St-Lorant

539.17

13290 THEORY OF ALLOWED AND FORBIDDEN TRANSITIONS IN MUON CAPTURE REACTIONS. II.

M.Morita and D.Greenberg.

Phys. Rev., Vol. 119, No. 1, 435-7 (July 1, 1960).

The general formalism of Pt I (Abstr. 9686 of 1960) is applied to the calculation of the angular distribution of the recoils in muon capture. Only the unique n-th forbidden transitions [spin change 0 → J, parity change $(-)^{J+1}$] are considered. As an example the special case of C^{12} is discussed. The angular distribution of the recoils depends strongly on the strength of the induced pseudoscalar interaction, but is rather insensitive to the assumption of conserved vector current.

539.17

13291 TOTAL ABSORPTION RATE OF MUONS IN CARBON. F.R.Stannard.

Phys. Rev. Letters, Vol. 4, No. 10, 523-4 (May 15, 1960).

Observations were made on 2519 muons stopped in a 30 in. propane bubble chamber. Capture stars with more than one prong or with one prong of energy > 15 MeV were taken to be due to pions. The effect of pion contamination was thus estimated. It was also estimated that 4 captures to form B^{12} were mistaken for decays. The corrected figures are 185 interactions and 2334 decays, giving a capture rate of $(0.36 \pm 0.04) \times 10^{5}$ sec^{-1}. This agrees with the modified prediction due to Flamand and Ford (Abstr. 4130 of 1960) of 0.41×10^{5} sec^{-1}.

A.Ashmore

539.17

13292 π^- CAPTURE IN COMPLEX NUCLEI AND NUCLEAR PAIR CORRELATIONS.

S.Ozaki, R.Weinstein, G.Glass, E.Loh, L.Neimala and A.Wattenberg.

Phys. Rev. Letters, Vol. 4, No. 10, 533-5 (May 15, 1960).

The two-nucleon of the capture process of π^- mesons by complex nuclei is examined by counter techniques. It is concluded, without without taking final-state interactions into account, that with Serber forces and the Pauli principle operative only in the initial states, the ratio of neutron—proton pairs to proton—proton pairs in carbon and aluminium is approximately 4.8.

S.J.St-Lorant

539.17

13293 ESTIMATION OF FISSION PRODUCT SPECTRA IN DISCHARGED FUEL FROM FAST REACTORS.

I.G.Dillon and L.Burris, Jr.

Nuclear Sci. Engng, Vol. 2, No. 5, 567-81 (Sept., 1957).

The fission product spectra in discharged fuel from fast fission power reactors have been calcultated over a wide range of operating conditions (reactor operating times from 10 to 10 000 days and cooling times from zero to infinity). These calculations are based on recent yield data for fission of uranium and plutonium. From these calculated data are presented derived data of total curies and energy dissipation rates as functions of operating time and cooling time.

539.17

13294 SLOW NEUTRON VELOCITY SPECTROMETER STUDIES OF THE TOTAL AND FISSION CROSS SECTIONS OF U^{235}.

E.Melkonian, V.Perez-Mendez, M.L.Melkonian, W.W.Havens, Jr. and L.J.Rainwater.

Nuclear Sci. Engng, Vol. 3. No. 4, 435-44 (April, 1958).

Results of cross-section measurements on U^{235} are presented. Parameters of some of the lowest energy levels are given. The observed average cross-sections in the energy region above 100 eV yield $\sigma_{n-\gamma}/\sigma_f = \alpha = 0.64$ and $\Gamma_n{}^0/D = 1.09 \times 10^{-4}$ in agreement with other observations.

539.17

13295 EXCITATION OF FISSION FRAGMENTS AND THEIR MASS DISTRIBUTION. B.T.Geilikman.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 955-8 (March, 1960). In Russian.

Considers the influence of shell effects on the elastic constant and mass coefficients of the vibrational degrees of freedom of a nucleus on the mass distribution of fission fragments and on the magnitude of their excitations energy.

539.17 : 539.

EMISSION OF BREMSSTRAHLUNG BY FISSION FRAGMENTS. See Abstr. 12898

539.

13296 THE ASYMMETRIC FISSION OF URANIUM NUCLEI B HIGH-ENERGY PROTONS. A.I.Obukhov.

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 271-3 (Jan., 1960). In Russian.

Uranium nuclei in an emulsion were bombarded with 460 and 660 MeV protons. The results show a much larger contribution frc symmetric fission than in the case of thermal-neutron fission of U^{235}. However, the contribution from extremely asymmetric deca increases slightly with energy.

J.A.Evar

539.

13297 FISSION OF URANIUM NUCLEI INDUCED BY 9 BeV PROTONS.

N.A.Perfilov, V.F.Darovskikh, G.F.Denisenko and A.I.Obukhov.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 716-18 (March, 1960). In Russian.

Some characteristics of uranium fission produced by 9 BeV protons were obtained and these include the magnitude of the cross section, dependence of the yield on the ratio of fragment ranges, data on the number of light charged particles, and angular distribu tions of the fragments.

539.

13298 ANGULAR DISTRIBUTION OF Na^{24} NUCLEI AND DEC FRAGMENTS IN THE INTERACTION OF HIGH-ENER PROTONS WITH GOLD AND URANIUM.

A.K.Lavrukina, L.P.Moskaleva, V.A.Malyshev, L.M.Satarova, Su Khun-Gui [Su Hung-Kuei].

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 994-5 (March, 1960). In Russian.

660 MeV protons were used; the decay fragments were absor in a beryllium plate which was then dissolved for chemical analys and measurements of activity by counters. A 1% silicon impurity the absorber led to large corrections to the results. A large forw peak in the Na^{24} distribution was found, which implies that this is a decay fragment, since an evaporation process leads to a near isotropic distribution. The Sr^{91} distribution is isotropic.

D.W.L.Spr

539

13299 THE YIELDS OF THE CHEMICAL ELEMENTS IN THERMAL NEUTRON FISSION OF U-235.

M.T.Robinson and J.F.Krause.

Nuclear Sci. Engng, Vol. 1, No. 3, 216-21 (July, 1956).

The yields of most of the chemical elements occurring in the neutron fission of U^{235} have been calculated from available data on mass yields, radio-active half-lives, and decay schemes of fissio product nuclides. The results of the computations are presented graphically.

539

13300 THE NEUTRON FISSIONABILITY OF U-239 AND Th- P.R.Fields, G.L.Pyle and W.C.Bentley.

Nuclear Sci. Engng, Vol. 2, No. 1, 33-7 (Feb., 1957).

The thermal neutron fissionability of U^{239} and Th^{233} were mea ed in the Materials Testing Reactor. An upper limit of 20 barns found for the thermal neutron fission cross-sections of these two isotopes.

539

13301 ENERGY RELEASE FROM THE DECAY OF FISSION PRODUCTS. J.F.Perkins and R.W.King.

Nuclear Sci. Engng, Vol. 3, No. 6, 726-46 (June, 1958).

The total disintegration rates, rates of beta- and gamma-ene release, and gamma-ray energy spectrum, are calculated for fis products due to thermal neutron fission of U^{235}. Information on d cay schemes was largely obtained from the compilations of the Nuclear Data Group of the National Research Council to July, 195 Total fission yields are from Katcoff and from Steinberg and Glendenin. Nuclear charge distributions are taken from Pappas' work, which includes the effect of closed shells. Reactor operati times of 1, 10, 100, and 1000 hours are treated, and the results otted for decay times ranging from 10^2 to 10^8 seconds. In addition, sults for instantaneous operation are compared to other calcula- ons and measurements. The present results fall below Way and gner's predictions of both disintegration rate and total energy re- ase over the entire range of decay times, though they agree satis- ctorily with the Way—Wigner rule-of-thumb expressions. The esent results are in very good agreement with experimental easurements. The gamma spectrum is found to vary considerably th decay time but to be only a weak function of reactor operating ne. The total beta and antineutrino energies per fission are found be 7.6 ± 0.5 and 10.0 ± 0.7, respectively.

539.17

13302 SUBCADMIUM IN-PILE ETAS AND ABSORPTION CROSS SECTIONS OF U^{233}, Pu^{239} AND Pu^{241}.

.R.Gaerttner, M.E.Jones, D.E.McMillan, J.B.Sampson and .M.Snyder.

uclear Sci. Engng, Vol. 3, No. 6, 758-71 (June, 1958).

Measurements of two independent types have been made of the eactivity effect in a thermal test reactor of samples of U^{235}, U^{233}, ^{239}, and Pu^{241}. From these measurements average subcadmium values relative to those of U^{235} are obtained independently of other owledge of the average absorption cross-sections. Average ab- rption cross-sections are also obtained from the measurements. alues of η for U^{233}, Pu^{239}, and Pu^{241} are respectively 2.231 ± 0.034 927 ± 0.024, and 2.213 ± 0.07. The corresponding value of (0.0253 eV) of Pu^{239} is found to be 2.025. A presentation of the ethod and results are given together with a comparison with evious work.

539.17

13303 COMPARISON OF THE AVERAGE NUMBER OF PROMPT NEUTRONS EMITTED IN THE FISSION OF U^{233}, U^{235}, ^{239}, AND Pu^{241}.

G.DeSaussure and E.G.Silver.

uclear Sci. Engng, Vol. 5, No. 1, 49-54 (Jan., 1959).

A fast coincidence technique was employed to measure the lative prompt-neutron yields per fission of U^{233}, U^{235}, Pu^{239}, and ^{241} induced by thermal neutrons. The values obtained were $/\nu^{25} = 1.02 \pm 0.01$, $\nu^{49}/\nu^{25} = 1.23 \pm 0.01$, and $\nu^{41}/\nu^{25} = 1.295 \pm 0.02$, ere ν^{23}, ν^{25}, ν^{49}, and ν^{41} designate the prompt-neutron yields of ^{33}, U^{235}, Pu^{239}, and Pu^{241}, respectively.

539.17

13304 INFLUENCE OF NUCLEAR SHELLS ON THE DISTRIBUTION OF THE KINETIC ENERGY OF RAGMENTS IN FISSION BY FAST NEUTRONS.

N.Protopopov, I.A.Baranov, Yu.A.Selitskii and V.P.Eismont.

h. eksper. teor. Fiz., Vol. 36, No. 6, 1932-3 (June, 1959). In ussian. English translation in: Soviet Physics—JETP (New York), ol. 36(9), No. 6, 1374-5 (Dec., 1959).

The distributions of the kinetic energy and of its half-width ow a peak at a fragment-mass ratio of 1.25-1.30 for U^{235} and U^{238}. her evidence also indicates a peak when the heavy fragment is ar the magic number 132. The effects are connected with the pendence of the shape of the fragment on the filling of the shells.

A.Ashmore

539.17

13305 MEASUREMENT OF THE SPECTRA AND THE AVERAGE NUMBER OF NEUTRONS EMITTED IN THE ISSION OF U^{235} AND U^{238} INDUCED BY 14.3 MeV NEUTRONS.

u.A.Vasil'ev, Yu.S.Zamyatnin, Yu.I.Il'in, E.I.Sirotinin, P.V.Toropov d E.F.Fomushkin.

h. eksper. teor. Fiz., Vol. 38, No. 3, 671-84 (March, 1960).

The fission neutron spectra and the average number of neutrons emitted in the fission of U^{235} and U^{238} induced by 14.3 MeV neutrons ere measured. The measurements were made at energies between 4 and 5 MeV by the time-of-flight technique in which a pulsed neu- on source is used. The spectra obtained are interpreted as con- sting of a distribution of neutrons emitted by the fragments and a stribution of neutrons evaporated prior to fission of the nucleus. e following distribution parameters were determined: $= (1.06 \pm 0.03)$ MeV, $T = (0.37 \pm 0.04)$ MeV and the fraction of aporated neutrons $\alpha = (16 \pm 2)\%$ for U^{235}; $T_f = (1.16 \pm 0.03)$ MeV, $= (0.4 \pm 0.04)$ MeV, $\alpha = (21 \pm 2)\%$ for U^{238}. The measured values $\bar{\nu}$ are 4.17 ± 0.30 for U^{235} and 4.28 ± 0.30 for U^{238}, their ratio ing $\bar{\nu}(U^{238})/\bar{\nu}(U^{235}) = 1.03 \pm 0.03$.

539.17

13306 ANGULAR DISTRIBUTION OF FRAGMENTS FROM FISSION OF Au^{197} WITH CARBON IONS.

E.Gordon, A.E.Larsh and T.Sikkeland.

Phys. Rev., Vol. 118, No. 6, 1610-11 (June 15, 1960).

The kinetic energy and angular distribution of fragments from fission of Au^{197} and 123 - and 93-MeV carbon ions were determined by observation of the fragments in gas scintillation and solid-state detectors. Between 20° and 160° in the centre-of-mass system, both angular distributions lie slightly above a $1/\sin\theta$ curve, falling below it beyond those angles. The anisotropies $[\sigma(0^\circ)/\sigma(90^\circ)]$ are 4.7 and 3.8 for 123- and 93 MeV carbon ions, respectively. The most probable fragment kinetic energies in the centre-of-mass system are 73 ± 3 and 71 ± 3 MeV.

539.17

13307 PROMPT NEUTRON PERIODS OF METAL CRITICAL ASSEMBLIES.

J.D.Orndoff.

Nuclear Sci. Engng, Vol. 2, No. 4, 450-60 (July, 1957).

Measurement of the time distribution of pairs of counts due to neutrons originating from a common ancestor in a neutron chain, yields a value for the prompt neutron period of a near-critical system. Such measurements can be used to establish the mass or control increment between delayed and prompt critical and, hence, constitute a reactivity calibration without use of the Inhour relation. Measurements are reported for several simple metal critical assemblies.

539.17 : 523.877

POSSIBILITY OF A FISSION CHAIN REACTION IN SUPERNOVA TYPE I. See Abstr. 12331

NUCLEAR POWER STUDIES

539.17

13308 HIGH FLUX REACTORS.

J.Chernick.

Nuclear Sci. Engng, Vol. 4, No. 6, 797-8 (Dec., 1958).

A short review.

539.17

13309 U-233 BREEDER-U-235 CONVERTER REACTOR.

L.I.Katzin and B.I.Spinrad.

Nuclear Sci. Engng, Vol. 1, No. 5, 343-54 (Oct., 1956).

A description of a fluid-fuel-fluid-absorber thermal reactor for the production of U^{233} is presented, the conditions required for maximum efficiency as a breeder (shortest doubling time) are elaborated. With very little modification of operating conditions and no modifications in the structure, the machine shows promise as an efficient U^{235}—U^{233} converter, with the possibility also of by-product power. Some of the development work required is indicated. In particular, achievement of high pumping rates for maximum heat transfer and fabrication of very thin-walled zirconium tubing pay large dividends.

539.17

13310 THE PARASITE REACTOR, A PRESSURE-BOMB ASSEMBLY FOR PHASE STUDIES UNDER IRRADIATION.

R.M.Bidwell and W.R.Wykoff.

Nuclear Sci. Engng, Vol. 1, No. 6, 443-51 (Dec., 1956).

The Parasite Reactor is a 1-litre pressure bomb for phase studies under irradiation at temperatures and pressures up to at least 400° C and 5000 psi. Provision was made for sampling of solid, liquid, and gas phases for analysis. Power output was measured. Yields of radiolytic gases were calculated. It was established that uranyl nitrate solutions are sufficiently stable up to 248° C to be used for a proposed high-pressure Water Boiler reactor.

539.17

13311 THE AIRCRAFT REACTOR EXPERIMENT — MOLTEN FLUORIDES AS POWER REACTOR FUELS.

R.C.Briant and A.M.Weinberg.

Nuclear Sci. Engng, Vol. 2, No. 6, 797-803 (Nov., 1957).

Molten fluorides of uranium, thorium, plutonium, and other elements potentially have wide applicability as fuels for power reactors. Because of their low vapour pressure they can be used in very high-temperature but low pressure liquid-fuel reactors. In addition, they possess great chemical flexibility — the molten-salt principle can be applied to burners, thorium-uranium thermal breeders, plutonium-uranium converters, and possibly even to fast plutonium breeders. Because of the very high thermal effiency obtainable in reactors using molten salt fuel, the fuel cost in a simple burner using enriched U^{235} is of the order of 2-3 mills/kWhr. A high-temperature reactor using molten uranium salts (Aircraft Reactor Experiment) was operated for a short time at the Oak Ridge National Laboratory. The reactor was of the circulating-fuel type, with a BeO moderator. The maximum outlet temperature achieved was greater than 1500°F. It is believed that with further development the ARE could be a prototype for an economical uranium burner.

539.17

13312 THE AIRCRAFT REACTOR EXPERIMENT — DESIGN AND CONSTRUCTION.

E.S.Bettis, R.W.Schroeder, G.A.Cristy, H.W.Savage, R.G.Affel and L.F.Hemphill.

Nuclear Sci. Engng, Vol. 2, No. 6, 804-25 (Nov., 1957).

The Aircraft Reactor Experiment was designed for operation at temperatures in the region of 1500°F at a power of 1 to 3 MW with a fluoride-salt fuel circulating in a heterogeneous core. The moderator was hot-pressed BeO blocks cooled by circulating sodium. The heat produced was dissipated in water through hot liquid-to-helium-to-water heat exchange systems. All sodium and fuel circuit components were made of Inconel fabricated by inert-gas (Heliarc) welding. The system was heated to design temperature by means of electrical heating units applied over all parts of the system. Instrumentation and control of the experiment were fairly conventional. For the most part, standard instruments were modified slightly for the high-temperature application. The reactor system was constructed and operated in a building specifically provided for the purpose.

539.17

13313 THE AIRCRAFT REACTOR EXPERIMENT — PHYSICS.

W.K.Ergen, A.D.Callihan, C.B.Mills and D.Scott.

Nuclear Sci. Engng, Vol. 2, No. 6, 826-40 (Nov., 1957).

The fluoride of a fissionable material dissolved in molten fluorides of other cations can serve as the fuel of a circulating-fuel nuclear reactor. These fluorides have a slowing-down power about one-half or one-fourth of the slowing-down power of dense graphite. The resonance escape probability depends strongly on the cation but is always less than that of carbon. The consequences of these properties for various reactor applications are discussed. Techniques for critical experiments for molten fluoride reactors have been developed, and the physics aspects of operation of the ARE have been analysed. Operation of the ARE demonstrated that molten-fluoride reactors have strong negative temperature coefficients, mainly as a result of fuel expansion. The ARE was shown to be very stable and to be a slave to the power load. No Xe^{135} poisoning was found in the ARE, and the radioactivity of the fuel after removal from the reactor was less that it would have been if all fission fragments had been retained. The loss of delayed neutrons by fuel circulation modified the inhour equation but not the stability of the ARE.

539.17

13314 THE AIRCRAFT REACTOR EXPERIMENT — OPERATION.

E.S.Bettis, W.B.Cottrell, E.R.Mann, J.L.Meem and G.D.Whitman.

Nuclear Sci. Engng, Vol. 2, No. 6, 841-53 (Nov., 1957).

The ARE was operated successfully in November, 1954, at various power levels up to 2.5 MW. The maximum steady-state fuel temperature was 1580°F, and there was a differential temperature between the inlet and outlet in the $NaF-ZrF_4-UF_4$ fuel of 355°F. The fuel system was in operation for 241 hr before the reactor first became critical and the nuclear operation extended over a period of 221 hr. The final 74 hr of operation were in the megawatt range and resulted in the production of 96-MWhr of nuclear energy. Effects of various transient conditions on reactor operation were determined.

539.17 : 539.1.07

THE NEUTRON SPECTRA FROM THE ZOE REACTOR.

See Abstr. 12792

539.17

13315 PLUTONIUM FAST POWER BREEDER WITH OXIDE FUEL AND BLANKET ELEMENTS.

J.B.Sampson and E.A.Luebke.

Nuclear Sci. Engng, Vol. 4, No. 6, 745-61 (Dec., 1958).

A fuel element consisting of plutonium and uranium oxide in steel tubing and capable of a large fraction of fuel burnup is described. As this fuel element makes possible recovery and refabrication with fewer steps than are required for a metal fuel element, lower recycle costs result. Breeders with fuel and fertile material in both oxide and metallic form were analyzed by the multigroup method on the UNIVAC for the purpose of comparing characteristics. A summary of the calculations is presented. The decrease in the breedi ratio resulting from the replacement of the metal core by oxide is only 0.2, a small effect in a future nuclear power economy where plutonium will have a low value as fuel rather than a high value as weapon material. Use of an oxide blanket may further reduce the breeding ratio by 0.05. An illustrative design is presented which five atoms of uranium per atom of plutonium in the core and 45% sodium, a breeding ratio of 1.4 and a critical mass of 400 kg. Inc mental refueling is assumed to reduce the control range required 50% burnup of the original fuel loaded.

539.

13316 A CORRECTION TO THE EFFECTIVE RESONANCE INTEGRAL IN HETEROGENEOUS NUCLEAR REACTC TO ALLOW FOR FUEL GEOMETRY.

M.H.McKay and A.Keane.

Austral. J. appl. Sci., Vol. 11, No. 1, 1-15 (March, 1960).

The effective resonance integral for heterogeneous lattices a postulated by Wigner (Abstr. 4111 of 1955) consists of a "volume-absorption" term and a "surface-absorption" term. The former i independent of the geometry of the fuel elements, but the latter is function of their surface-to mass ratio. Approximations to the collision probability within the fuel elements made by Wigner, Chernick, and others have simplified the calculation of the effecti resonance integral, reducing it to the equivalent of the homogeneo case, but these approximations lead to considerable inaccuracy in the surface-absorption term and its relation to the geometry of th fuel elements. In the present paper the method of Gurevich and Pomeranchouk (1955) is applied to evaluate the surface term of Wigner's effective resonance integral without making the above approximations, thus giving much more accurately its dependence on the surface-to mass ratio of the fuel elements. Comparisons are made with the results obtained by using the former approximations, and the application of a correction factor in the evaluation o the effective resonance integral is suggested. This correction factor is calculated and tabulated for uranium and thorium fuel elements of various shapes and sizes and a graph is given from which the appropriate correction factor for other fuels may be evaluated.

539.

13317 FAST EFFECT IN LATTICE REACTORS.

B.I.Spinrad.

Nuclear Sci. Engng, Vol. 1, No. 6, 455-60 (Dec., 1956).

An argument is made for defining the fast fission factor ϵ as the number of neutrons making first collision with moderator per neutron arising from thermal fission. Formulae for the fast effec in U^{238} lattices are presented; the (productive) absorption associat with fast effect is also formulated. The implications of this point view with regard to measurements of resonance escape probabilit and resonance integrals are discussed.

539

13318 AN APPLICATION OF REACTOR KINETICS TO THE ANALYSIS OF EXPERIMENTS.

A.F.Henry.

Nuclear Sci. Engng, Vol. 3, No. 1, 52-70 (Jan., 1958).

The conventional kinetics equations for reactors in which fuel is stationary are derived without approximation from the time-dependent transport equation. The utility of the precise form whi results is discussed, first generally, then with reference to the de tailed analysis of two typical experiments. It is shown that the a lysis required for a precise interpretation of kinetics experiment can generally be made using the same techniques employed in the computation of criticality for stationary cases.

539

13319 THE DETERMINATION OF REACTOR TRANSFER FUNCTIONS FROM MEASUREMENTS AT STEADY OPERATION.

M.N.Moore.

Nuclear Sci. Engng, Vol. 3, No. 4, 387-94 (April, 1958).

Upon application of the theory of stochastic processes to rea kinetics, it is possible to show that the square of the modulus of t reactor transfer function is proportional of the Fourier transforn of the autocorrelation function for power noise in the reactor. Si the power noise represents the response to the minimum power i signal, measurements of transfer functions based upon reactor n are of all possible measurements, least subject to nonlinear distortion. By performing the experiment at various power levels a temperatures, it is possible to measure both power and temperat coefficients. If the reactor is periodically monitored during its operation, long term changes can also measured.

539.17

3320 TRANSFER FUNCTIONS OF DISTRIBUTED PARAMETER NUCLEAR REACTOR SYSTEMS.

.Gyftopoulos and H.B.Smets.

lear Sci. Engng, Vol. 5, No. 6, 405-14 (June, 1959).

Transfer functions of nuclear reactors and counterflow heat hangers are derived from the partial differential equations with pect to time and spatial coordinates describing the transient be- iour of nuclear power plants. These transfer functions can be roximated by lumped electrical networks and pure delays for logue computer studies. The procedure of approximation is illus- ted by specific examples.

539.17

13321 GENERAL SOLUTION OF THE REACTOR KINETIC EQUATIONS WITHOUT FEEDBACK. Z.Akcasu.

clear Sci. Engng, Vol. 3, No. 4, 456-67 (April, 1958).

Kinetic equations without the feedback are integrated for an bitrary reactivity variation, assuming that the magnitude of the nges in the excess reactivity is less than one dollar. First and cond approximations are obtained. The results are applied to the p, ramp, and periodical reactivity changes. It is found that the arithm of the flux, in the first approximation, is given by the ction which is the solution of the linearized kinetic equations for flux. Hence, the usual transfer function approach can be used form the first approximate solution of the nonlinear kinetic equa- ns. The wave form of the flux is obtained for a sinsoidal input, l the second harmonic is calculated. The exponential rise in the erage value, as well as in the amplitude, of the oscillations of the x is given for an alternative reactivity input. The gain of the ctor is defined. It is shown that the relative gain of the reactor creases slightly with the increasing amplitude of the sinusoidal ut. The results are compared to a numerical solution obtained by IDAC.

539.17

13322 KINETICS OF HOMOGENEOUS POWER REACTORS OF THE LAPRE TYPE. J.C.Allred and D.S.Carter.

clear Sci. Engng, Vol. 3, No. 5, 482-503 (May, 1958).

A theoretical study of the kinetics of a model of the Los Alamos ver Reactor Experiments (LAPRE) has been made through inte- tion of the dynamic equations with the IBM 701 computer. The sta- ty is investigated under various conditions of power demand, rod- uced reactivity changes, and other conditions especially applicable reactors of the LAPRE type. The results are given in graphical m, along with conclusions as to appropriate conditions of operation.

539.17

13323 CRITICAL PARAMETERS OF A PROTON-MODERATED AND PROTON-REFLECTED SLAB OF U^{235}

.Fox, L.W.Gilley and J.H.Marable.

clear Sci. Engng, Vol. 3, No. 6, 694-7 (June, 1958).

The critical thickness of proton moderated and proton reflected b-shaped volumes of aqueous solutions of UO_2F_2 enriched to 93.2% U^{235} were measured at chemical concentrations near that required minimum critical volume. These data yield 1.76 ± 0.07 in. as minimum critical thickness of an infinite slab of the materials the experiment at a concentration of 532 g U^{235}/1. This result is mpared with a three-group two-region analysis of the infinite b.

539.17

13324 THE GENERAL CRITICAL REACTOR EQUATIONS. M.J.Nowak.

clear Sci. Engng, Vol. 4, No. 1, 25-43 (July, 1958).

A general formulation of the critical reactor equations is made include space and velocity variation; the noncritical reactor is ated by using the effective multiplication factor. Two methods developed for solving the general equation by splitting it into a r of simultaneous equations: the space-energy split and the sion source split. By using unit sources one equation can be erted to obtain a pair of integral equations for iterative solution the general equation. The meaning of neutron importance and sical picture associated with the concept are given. By using physical meaning the importance balance equation, which is oint to the neutron flux equation, is derived by several methods. utron importance is used to formulate the change in reactor ver produced by a change in reactor parameters. The effective ltiplication factor and reactivity are introduced;the perturbation ation for reactor power change is developed in terms of reacti- y. The necessary assumptions to derive the diffusion approximation are given, and the general diffusion equation with continuous energy dependence is obtained. From this the multigroup diffusion equations can be obtained, including the multigroup diffusion perturbation equations. The same methods used for the general critical reactor equation are applied to the diffusion equation to obtain its solution by splitting it into a pair of coupled integral equations. The integral equation for the effective multiplication factor is developed in terms of the fission source variable, and a stationary variational formula obtained for estimating the effective multiplication factor.

539.17

13325 A MONTE CARLO METHOD FOR CRITICALITY PROBLEMS. W.Goad and R.Johnston.

Nuclear Sci. Engng, Vol. 5, No. 6, 371-5 (June, 1960).

An efficient Monte Carlo method is described for computing the fundamental eigenvalue of the homogeneous transport equation. Importance sampling is used and, in effect, one neutron is followed through a large number of collisions.

539.17

13326 DETERMINATION OF k_∞ FROM CRITICAL EXPERIMENTS WITH THE PCTR.

D.J.Donahue, D.D.Lanning, R.A.Bennett and R.E.Heineman.

Nuclear Sci. Engng, Vol. 4, No. 3, 297-321 (Sept., 1958).

The PCTR is a seven-foot cube of graphite with a large cavity, 2 × 2 × 3 ft, located at its centre. It is made critical by enriched uranium which is distributed on the boundary of the central cavity. One end of the assembly, 2 × 7 × 7 ft, is mounted on a movable cart, and can be moved away from the reactor proper allowing access to the central test region. The infinite medium, thermal neutron multiplication factor, k_∞, of a multiplying material is obtained by determining the amount of thermal absorber, which, when inserted with the multiplying material into the central region of the PCTR, will change neither the reactivity of the assembly nor the energy distribution of neutrons in it. The design of the reactor and the method used for determining this absorber mass are discussed and results for two graphite-natural uranium lattices are presented.

539.17

13327 EFFECTS OF LOW-LYING EUROPIUM RESONANCES ON THE TEMPERATURE DEFECT IN WATER-MODERATED REACTORS.

D.M.Keaveney, T.J.Krieger and M.L.Storm.

Nuclear Sci. Engng, Vol. 4, No. 3, 332-40 (Sept., 1958).

The selection of appropriate epithermal group-averaged cross-sections for use in a few-group criticality calculation is particularly difficult when resonance absorbers are present. However, by use of the SOFOCATE code for the calculation of thermal spectra in hydrogenous media, it is now practical to include low-lying resonances below 2 eV in the thermal group. Since the SOFOCATE code, which is based on the Wigner—Wilkins differential equation for monatomic hydrogen thermalization, has yielded good agreement with measured spectra in water, it is felt that use of this code and inclusion of low-lying resonances in the thermal group constitute a more accurate and convenient method of treating these resonances than other procedures. As an application of the method, a study has been made of some of the effects associated with the use of Eu as a means of reducing the temperature defect in water-moderated reactors. It is shown that the use of natural, unshielded Eu would reduce the temperature defect provided the spectral hardening introduced by the core absorption is sufficiently small. It is also shown that the strong dependence on spectral hardening is due to the presence of the Eu resonances at about 0.4 eV.

539.17

13328 EFFECT OF ALLOYING ON THE CRITICAL MASS OF A PLUTONIUM SPHERICAL FAST REACTOR.

J.T.Waber, M.R.Kline and L.K.Johnson.

Nuclear Sci. Engng, Vol. 4, No. 3, 341-53 (Sept., 1958).

The effect of alloying on the amount of plutonium required in forming a critical mass of each alloy has been expressed in terms of an inventory requirement ratio, R_I. This quantity was obtained for twenty-seven potential alloying elements at three compositional levels. The effectiveness of using Vegard's law to estimate the density of the alloys was appraised by comparing the estimated densities and R_I values of nine intermetallic compounds with their X-ray densities and the R_I values computed from them. The parametric variation of R_I with f_T, the number of excess neutrons per collision,was also studied.

539.17

13329 THE KINETICS OF CIRCULATING FUEL REACTORS. J.MacPhee.

Nuclear Sci. Engng, Vol. 4, No. 4, 588-97 (Oct., 1958).

Various methods of approximating the kinetics of circulating fuel reactors are investigated. As the basis for comparison, a relatively "exact" model is used, predicated on perfect mixing in the core and slug flow in the external loop. The derivations and applicability of the various approximate methods are presented. It is shown that the frequency response of the "exact" model can exhibit peaking (i.e., resonances). The effect of such peaking on the transient response of the system is illustrated. The possibility of self-sustained oscillations of reactor power, resulting from the feedback caused by delayed neutron precursors re-entering the core, is also discussed.

539.17

13330 A DIRECT MEASUREMENT OF THE URANIUM METAL TEMPERATURE COEFFICIENT OF REACTIVITY.

R.M.Pearce and D.H.Walker.

Nuclear Sci. Engng, Vol. 2, No. 1, 24-32 (Feb., 1957).

The uranium metal temperature coefficient of reactivity has been measured in Zeep. A uranium sample was oscillated in the reactor and the resulting modulation of reactor power was measured as a function of the sample temperature. The temperature coefficient of uniformly heated uranium rods, 3.25 cm in diameter, immersed in a constant temperature moderator (moderator-to-uranium volume ratio 22) is deduced from this experiment. Over the range + 30° C to + 230° C the coefficient is $dk/dT = -(1.25 \pm 0.09) \times \times 10^{-5}$ per °C. Over the range + 10° C to −140° C the coefficient is $dk/dT = -(1.58 \pm 0.18) \times 10^{-5}$ per °C.

539.17

13331 SOURCES OF ERROR IN REACTIVITY DETERMINATIONS BY MEANS OF ASYMPTOTIC PERIOD MEASUREMENTS. B.J.Toppel.

Nuclear Sci. Engng, Vol. 5, No. 2, 88-98 (Feb., 1959).

A common method used to determine reactivity is to measure the reactor period and then refer to the inhour equation which relates asymptotic period to reactivity. The implicit assumption in such a method is that the neutron population is varying exponentially with time. The conditions necessary for this assumption to be valid have been obtained by a quantitative examination of the time behaviour of the neutron population. The results obtained show that under common experimental conditions, several minutes may be required following a positive step change in reactivity in order to achieve accuracy by means of a period determination. In addition, in the case of the reactor with a constant extraneous source, a significant increase in this waiting time can result even if the reactor is initially only very slightly subcritical. Whereas in principle both positive and negative reactivities may be obtained from period observations, it is pointed out that in practice serious objections exist for the case of negative reactivities.

539.17

13332 PERIOD—REACTIVITY RELATIONS DETERMINED DIRECTLY FROM PROMPT-BURST NEUTRON DECAY DATA. G.R.Keepin.

Nuclear Sci. Engng, Vol. 5, No. 2, 132-6 (Feb., 1959).

Reactor period—reactivity relations may be determined directly by numerical integration of "prompt-burst" neutron decay data without analysis into delayed neutron period and abundance values. Period—reactivity relations obtained by this method for six fissile species are compared with the corresponding relations calculated from the customary "inhour" equation. Application of this method to mixtures of fissile materials in various neutron energy spectra is discussed.

539.17

13333 ANALYSIS OF REACTOR OSCILLATIONS FOR COEFFICIENTS OF REACTIVITY.

H.D.Brown and W.E.Loewe.

Nuclear Sci. Engng, Vol. 5, No. 6, 376-81 (June, 1959).

Temperature coefficients in large reactors can be obtained from the transient response of the flux to oscillations of control rods. A method is described with which the coefficients can be measured under full operating conditions and without special instrumentation or access to the pile. The technique is particularly useful in measuring the dependence of the coefficients upon hydraulic conditions, power level, and fuel exposure. The waveform of the perturbing oscillation of reactivity is trapezoidal so that the regular reactor control system can be used. In large reactors the flux shape chan during the portion of the cycle when the control rods are moving, only the magnitude of the flux changes significantly while the contr rods are stationary. The flux response during this latter portion the cycle is analysed for the temperature coefficients. The pile kinetics equations, coupled with equations for the temperatures of fuel, coolant, and moderator, are solved for the flux during the im posed oscillation. The temperature coefficients and their delay times are found by fitting computed fluxes to the observed flux.

539

13334 SUBCRITICAL ASSEMBLIES WITH SPONTANEOUS FISSION SOURCE. P.Jauho.

Ann. Acad. Sci. Fennicae A VI, No. 41, 16 pp. (1960).

With the aid of the integro-differential Boltzmann equation fo the flux in a bare subcritical assembly, a theoretical expression for the absolute value of the flux caused by spontaneous fission neutrons is derived. In the derivation, it is assumed that Fourier transforms of the slowing-down kernels depend only on the absolu value of the buckling vector and further that the energy spectra fo spontaneous and induced fission neutrons are identical. The corr tion to the value of the flux due to the presence of the moderator i discussed and an expression for this correction is derived. The theory is then applied to measurements made with the aid of the natural uranium-light water subcritical assembly of Finland's Institute of Technology. The result obtained for the spontaneous fission half-life is $(6.5 \pm 2.0) \times 10^{15}$ y.

539.

13335 HOMOGENEOUS HEAVY WATER MODERATED CRITICAL ASSEMBLIES. I. EXPERIMENTAL.

R.N.Olcott.

Nuclear Sci. Engng, Vol. 1, No. 4, 327-41 (Aug., 1956).

Ten critical assemblies of enriched uranyl-fluoride heavy-water solutions have been studied. In six cases, heavy water reflectors surrounded solutions in which the atomic ratio of deute ium to uranium-235 varied from 34 to 430. The remaining four assemblies were without reflector and the deuterium to U^{235} ratio ranged from 230 to 2080. Activation rates within the systems wer measured for the resonance detectors In, Au, Pd, and Mn and for the fission detectors U^{235}, U^{238}, Pu^{239}, and U^{233}.

539

13336 APPLICATION OF MINIMUM LOADING CONDITIONS TO ENRICHED LATTICES.

P.L.Hofmann and H.Hurwitz, Jr.

Nuclear Sci. Engng, Vol. 2, No. 4, 461-8 (July, 1957).

The distribution of enrichment which makes a natural uraniu lattice with $k_{\infty} < 1$ critical with the smallest amount of added U^{23} is calculated on the basis of a simple model. The results are generalized to the minimization of total enrichment cost when thi cost is a nonlinear function of the added fissionable material.

539

13337 NEUTRON SELF-SHIELDING IN A SIMPLE PLANE LATTICE. J.Bengston.

Nuclear Sci. Engng, Vol. 3, No. 1, 71-6 (Jan., 1958).

A generalization of the Serber—Wilson method has been used derive an expression for the one neutron group self-shielding fact for an absorbing material alternating with a pure moderator and scatterer in a simple plane lattice. The formula has been found a accurate as a considerably more complicated double spherical ha monic calculation.

539

13338 TWO-DIMENSIONAL (r,z) MULTIGROUP CALCULA FOR AN INTERMEDIATE SPECTRUM CRITICAL ASSEMBLY. P.L.Hofmann and M.L.Storm.

Nuclear Sci. Engng, Vol. 3, No. 3, 313-38 (March, 1958).

The results of two-dimensional (r,z) multigroup calculations of an experimental low-power reactor (PPA-19) are described. Comparison is made between calculated results and experimenta measurements of reactivity, power distribution, and sodium acti tion. Generally good agreement is observed between calculation and experiment. This calculation was performed in 1954 and represents the first application of Roe's two-dimensional multigro formulation to the analysis of an operating critical assembly. T overall objective of such calculations is to ascertain the accura of two-dimensional multigroup methods in order to facilitate the application to future problems in reactor design.

539.17

13339 MEASUREMENTS OF THERMAL UTILIZATION, RESONANCE ESCAPE PROBABILITY, AND FAST FFECT IN WATER-MODERATED, SLIGHTLY ENRICHED URANJM AND URANIUM OXIDE LATTICES.

.Klein, A.Z.Kranz, G.G.Smith, W.Baer and J.DeJuren.
uclear Sci. Engng, Vol. 3, No. 4, 403-27 (April, 1958).

Measurements of thermal utilization, resonance escape probbility, and fast effect have been made in 1.3% enriched uranium ietal and uranium oxide fueled lattices. Parameter measurements ere made in oxide lattices of fuel densities 7.53 g/cm^3 and 0.53 g/cm^3. Experimental results were obtained in lattices having .600-inch and 0.387-inch diameter rods at several water-toranium ratios. Values of the parameters have also been determined r two 1.15% enriched metal fueled lattices.

539.17

13340 SOME APPLICATIONS OF THE S_n METHOD.

R.M.Kiehn.
uclear Sci. Engng, Vol. 4, No. 2, 166-79 (Aug., 1958).

The S_n technique, a method devised by Carlson to solve the ransport equation, has been applied to a number of critical assembly roblems. A comparison of computed and experimental results is iven.

539.17

13341 FLUX DISADVANTAGE FACTOR IN PLANE SLAB LATTICES.

E.R.Cohen.
uclear Sci. Engng, Vol. 4, No. 2, 255-6 (Aug., 1958).

Bengston has calculated the neutron self-shielding in lattices, ssuming a periodic plane lattice of nonscattering absorber, thickess 2a, and nonabsorbing moderator, thickness 2(b-a). This note oints out that under these assumptions a much simpler calculation s possible.

539.17

13342 CALIBRATION OF ORNL LID-TANK FISSION PLATES.

W.J.McCool and D.R.Otis.
ucleonics, Vol. 18, No. 4, 98, 100, 122, 123 (April, 1960).

The SP-2 fission plate has been calibrated by three methods: a) estimation by gold wire activation of incident neutron flux and of he thermal ultilization within the plate by a transmission experinent; (b) measured neutron emission rate; (c) measurement of heat roduction within the plate. The source strength found was 4.87 W r neutrons and 4.56 W for gammas. The strength of the previous late SP1 was estimated to be 1.7 W for neutrons and 1.14 W for ammas.

R.D.Smith

539.17

13343 VARIATIONAL CALCULATIONS OF LATTICE SELF-SHIELDING.

L.S.Bohl, J.C.Stewart and N.C.Francis.
uclear Sci. Engng, Vol. 4, No. 2, 257-9 (Aug., 1958).

A method for handling one-velocity lattice self-shielding prolems has been derived by Bengston (Abstr. 13337 of 1960) based on he Serber—Wilson procedure of using the exact transport equation o obtain boundary conditions on diffusion-theory solutions. In his est case, an alternating fuel-moderator lattice of fairly thin slabs, he method gave accuracy comparable with that of the much more aborious double-P_3 method. This paper presents a variational nethod which yields extremely accurate results with brief hand alculation in problems of this type.

539.17

13344 TWO REGION STUDIES IN SLIGHTLY ENRICHED WATER-MODERATED URANIUM AND URANIUM DIXIDE LATTICES.

.J.Volpe, G.G.Smith, D.Klein, F.S.Frantz and J.C.Andrews.
uclear Sci. Engng, Vol. 5, No. 6, 360-70 (Feb., 1959).

An experimental and analytical study of the flux distribution of vo-region core configurations has been made for the TRX facility: he purpose of this study was to obtain an estimate of the sizes of ritical configurations that would yield the same values of the basic eactor parameters in the inner region as a critical core consisting ntirely of the inner region material and geometry. Several twoegion cores have been constructed and experimental measurements f thermal utilization, resonance escape probability, and fast fission ffects have been performed. Slow and fast neutron activation disributions have also been obtained. Two inner regions were construced utilizing 1.3 w/o enriched UO_2 fuel 0.384 in. in diameter and with density of 10.53 gm/cm^3. A third inner region utilized 1.3 w/o nriched uranium metal fuel with a diameter of 0.387 in. Light water served as the moderator and reflector in all cases. The experimental and theoretical results indicate that by utilizing tworegion cores, measurements of microscopic parameters can be made for a wide variety of fuel sizes, fuel enrichments, and water-touranium volume ratios without the construction of full critical cores for each combination.

539.17

13345 PROMPT NEUTRON PERIODS OF A CRITICAL ASSEMBLY MEASURED WITH A PULSED SOURCE.

P.J.Bendt, H.J.Karr and F.R.Scott.
Nuclear Sci. Engng, Vol. 4, No. 6, 703-8 (Dec., 1958).

The prompt neutron period of a bare sphere of U^{235} has been measured at two reactivities between delayed and prompt critical. The X-ray burst from a betatron was used to establish the initial neutron population in the critical assembly, and the neutron intensity was observed by photographing oscilloscope traces of pulses from a spiral fission chamber. The values obtained for α, the reciprocal of the prompt neutron period, are $(-0.52 \pm 0.03) \times 10^6$ sec^{-1} at 54 cents reactivity, and $(-0.26 \pm 0.03) \times 10^6$sec^{-1} at 76 cents.

539.17

13346 OPERATING CHARACTERISTICS OF A GRAPHITE-MODERATED SUBCRITICAL ASSEMBLY.

R.E.Uhrig.
Nuclear Sci. Engng, Vol. 5, No. 2, 120-6 (Feb., 1959).

The Iowa State College subcritical assembly is a natural uranium-graphite pile constructed as a teaching tool to illustrate the principles of nuclear physics and engineering and as a facility for graduate thesis research in nuclear engineering. The determination of the basic operating characteristics of this assembly is described and discussed. The material buckling as determined from flux measurements was the parameter used in comparing the results. Tests were conducted for the 6 in., 8½ in., and 12 in. lattice arrangements and for all uranium removed. Tests were made with air and water in the coolant annuli surrounding the uranium slugs. Bucklings were calculated using the elementary theory of Murray (in which all extraneous materials are treated as poisons) and the method of Volkoff and Rumsey (in which the moderating effect of the water and the shielding effects of the various materials are considered) for the three lattice arrangements, and they are compared with the experimental results. The position of the neutron sources in the source compartment and the presence of water around the sources were found to affect the measured value of material buckling.

539.17

13347 ON REACTOR PHYSICS PERTURBATION THEORY OF HIGHER ORDER AND THE RANGE OF VALIDITY OF THE PERTURBATION THEORY OF FIRST ORDER IN THE CASE OF THE TREATMENT OF CAVITIES.

H.Dušek and W.Oldekop.
Nukleonik, Vol. 1, No. 9, 342-6 (Dec., 1959). In German.

The first order theory described is developed from the multigroup collision equations; it can be applied to systems containing cavities. It is extended to a second order theory by a P_1-approximation, so that the range of validity of the first order theory can be estimated. This technique is applied to a homogeneous plane and a spherical reactor with cavities.

D.H.Lord

539.17

13348 A SYSTEM OF OBTAINING AND REDUCING NEUTRON FLUX DATA FROM A CRITICAL ASSEMBLY.

H.A.Morewitz and R.F.Valentine.
Nuclear Sci. Engng, Vol. 4, No. 1, 73-81 (July, 1958).

Some new techniques have been applied in the determination of relative neutron fluxes in water moderated critical assemblies. Alloy wires of Mn—Fe, In—Al, Au—Al, and U—Zr have been prepared with a high degree of uniformity between individual samples of a given material. Beta activation of these wires is measured by thin scintillation crystals in conjunction with specially stabilized electronics. This procedure results in good "plateaux" of counting rate versus photomultiplier voltage, discriminator setting, and amplifier gain. The counting time of a wire is controlled by a decaying sample of the activated material. Thus, as the counting continues, the counting interval becomes progressively longer, providing automatic decay correction of the data. Several benefits obtain from this method. The statistics of counting for a wire of a given activation level are independent of the time of counting; nonuniform decay (e.g., mixed fission product decay) is handled with the same facility as simple exponential decay. Automatic sample changers are used which make possible the counting of larger numbers of samples (approximately 1500 per day) with a minimum of personnel. These changers have been so adjusted that good precision in positioning is maintained. The automatic features of the counting system permit a rapid qualitative evaluation of the data. An error analysis has been made which indicates an experimental counting error (exclusive of statistical error due to decay) of approximately 0.8%. This error, when combined with the appropriate statistical error, has been applied to improve the use of computer codes in obtaining accurate least square fits of theoretical curves to the experimental data.

539.17 : 539.12

ON THE THEORY OF THE DIFFUSION COOLING OF NEUTRONS IN A FINITE SOLID MODERATOR ASSEMBLY. See Abstr. 12992

539.17

13349 VERIFICATION OF A METHOD FOR TREATING NEUTRON SPACE—TIME PROBLEMS.

A.F.Henry and N.J.Curlee.

Nuclear Sci. Engng, Vol. 4, No. 6, 727-44 (Dec., 1958).

An approximation method is proposed for calculating the detailed kinetic response of a reactor during a transient in which the space and time behaviours of the neutron flux are not separable. In order to test the validity of the method a particular transient is studied for a series of cores chosen so that the space—time behaviour of the neutrons is nonseparable in varying degrees. A particularly simplified mathematical description of the neutrons allows an exact solution to be obtained and hence affords a means of verifying predictions of the approximation scheme. Agreement between exact and approximate calculations is encouragingly good.

539.17

13350 FAST FISSION EFFECT IN LATTICES OF NATURAL URANIUM AND HEAVY WATER. A.H.F.Futch, Jr.

Nuclear Sci. Engng, Vol. 5, No. 1, 61-7 (Jan., 1959).

The ratio δ, of U^{238} to U^{235} fissions was measured for various natural uranium fuel assemblies in D_2O-moderated reactor lattices. Fuel element types studied included clusters of from one to nine 1 in. rods, tubular assemblies, and plate assemblies. The measurements were made by comparing the activations of depleted and natural uranium foils after irradiating them inside the fuel assemblies in an exponential facility. As a corollary to these experiments, relative decay rates were determined for the gamma activities of the U^{238} and U^{235} fission products.

539.17

13351 AVERAGE FLUX IN REACTOR TEST VOLUMES.

R.L.Murray, G.H.Katzin and A.L.Mowery, Jr.

Nuclear Sci. Engng, Vol. 5, No. 1, 69-70 (Jan., 1959).

The prediction of reaction rates of neutrons with nuclei within a finite sample in a research or test reactor requires the computation of the average neutron flux over the region. Formulae are presented in this note that facilitate such evaluations for off-centre samples. Cylindrical symmetry of the basic reactor flux distribution is assumed. The functions that make up $\phi(r)$ are known, for example, by previous one- or two-group calculations.

539.17

13352 A TIME-DEPENDENT ANALYSIS OF SPATIAL FLUX DISTRIBUTIONS. H.L.Garabedian and C.B.Leffert.

Nuclear Sci. Engng, Vol. 6, No~~. 1, 26-32 (July, 1959).~~

A technique is exhibited which permits an investigation of the changes in flux shape which occur when reactivity is inserted locally in an inhomogeneous reactor system and the power level rises. Thus, transient flux shapes at any time may be found as well as the asymptotic flux shape which is eventually attained. The reactor kinetics study in this article is motivated by a method of harmonics which does not employ the conventional assumption of separability of the flux into a product of a function of position alone and a function of time alone. From the point of view of practical applications the method is restricted to systems of rather simple geometry in which the slowing down is everywhere uniform and in which there are no nonlinear feedback effects.

539.17

13353 TWO-GROUP ALBEDO THEORY AND APPLICATION TO TEMPERATURE COEFFICIENT CALCULATIONS.

A.Jacobs.

Nuclear Sci. Engng, Vol. 6, No. 2, 147-51 (Aug., 1959).

A two-group albedo theory is developed which seems to be valid for the calculation of temperature coefficients of nuclear reactors characterized by the PSR*. Measurements of over-all coefficients for the PSR are in qualitative agreement with results calculated by the theory.
Analysis under the present theory singles out the temperature var
tion of the ratio of the age to the thermal neutron diffusion length
the reflector as the primary contributor to a low temperature pos
tive coefficient effect. The advantage of representing the critical
factor, k, by the two-group albedo theory is well illustrated by the
endeavour of calculating the temperature coefficient. Under norm
two-group multiregion treatment the criticality factor never expli
appears and therefore it is impossible to obtain an explicit form o
the variation of k with system parameters. The dissection of the
nonleakage probability in the present theory is not unique, but it d
lead to easy physical interpretation.

*Pennsylvania State University Research Reactor (swimming-pool type).

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13354 THE EFFECTIVE CROSS SECTION OF Pu^{240} IN LONG-TERM REACTIVITY CALCULATIONS.

R.L.Crowther and J.W.Weil.

Nuclear Sci. Engng, Vol. 3, No. 6, 747-57 (June, 1958).

The presence of a large, sharp resonance at 1 eV in Pu^{240} results in the effective pile cross-section for this isotope being ver
much larger than the true thermal cross-section. Furthermore,
narrowness of this resonance causes the absorption of epithermal
neutrons in Pu^{240} to be strongly self-shielded. Consequently, the
effective cross-section of Pu^{240} will be a function of reactor spectrum and of the Pu^{240} concentration at any given time. The signi
cance of this effect can be appreciated by noting that the effective
cross-section of this isotope is frequently more than twice the ef
tive thermal value. An approximate method of calculation has be
applied to long term reactivity problems. The importance of the
resonance augmentation and concentration dependence of the Pu
cross-section is particularly evident in the first few thousand MWd
and causes significant changes in the reactivity required to reach
any longer burnout. Sample calculations are presented and comparisons with the Canadian experimental determinations of the ef
tive Pu^{240} cross-section are made. An effective constant Pu^{240}
cross-section is presented which will yield approximately correc
burnout results when used in conventional irradiation studies.

53

13355 GRAPHITE IN NUCLEAR REACTORS. V.V.Goncharov.

J. nuclear Energy, Vol. 7, No. 1-2, 115-24 (Aug., 1958). English translation from: Atomnaya Energiya, Vol. 3, No. 11, 398 (1957)

Graphite for use as moderator must be of high purity and hig
density. The physical and chemical properties of graphite are re
viewed and methods of production described. In the USSR a petro
leum coke containing 0.04% of ash is used as raw material, and t
graphite produced has a density of 1.70 g/cm^3 and contains 30 p.p
of ash and 0.245 p.p.m. of boron. The effects of radiation on the
physical properties of graphite are summarized. R.D.Sm

53

13356 THEORY OF PULSED NEUTRON EXPERIMENTS IN MULTIPLYING MEDIA.

T.J.Krieger and P.F.Zweifel.

Nuclear Sci. Engng, Vol. 5, No. 1, 21-7 (Jan., 1959).

The spatial and temporal distribution of thermal neutrons in
multiplying assembly following the introduction of a short burst
fast neutrons is investigated by means of an extension of the so-called "asymptotic reactor theory" to the time-dependent case.
is shown that the solution for an n-th mode fast neutron source ca
be reduced to that for an n-th mode thermal neutron source, so th
only the latter need be considered. A formal solution to the time
dependent thermal diffusion equation with an n-th mode thermal so
is found for an arbitrary slowing-down kernel. The asymptotic b
haviour of the flux in the long-time limit is shown to be exponent
with a decay constant satisfying a generalized material buckling
equation. The asymptotic behaviour following a burst of fast neut
is also found to be exponential with the same time constant. In a
continuous slowing-down model, all neutrons slow down in the sa
time, implying that the time-dependent part of the time-depender
slowing-down kernel is a Dirac delta-function. In this case, an
plicit expression for the flux following a burst can be derived, fr
which the approach to the asymptotic behaviour is clearly seen.
mean slowing-down time $\langle t \rangle$ is used to find an approximate expr
sion for the asymptotic decay constant. To evaluate $\langle t \rangle$ for hydr
genous media, it is noted that the Laplace transform of the Boltz
equation is identical with the time-independent Boltzmann equati
if, in the latter, $\Sigma_a(E)$ is replaced by $\Sigma_a(E) + \eta / v(E)$, where v(E)

e neutron velocity and η the Laplace transform variable. The re-iting equation can then be solved by standard methods. The in-ite medium ($B^2 = 0$) result of 0.92 μsec for the slowing-down time 1.4 eV is in good agreement with the value 0.85 μsec obtained m Monte Carlo calculations. The validity and application of the thod are discussed.

539.17 : 536.2

13357 HEAT TRANSFER IN A CROSS FLOW NUCLEAR REACTOR. C.L.Larson.

clear Sci. Engng, Vol. 4, No. 5, 607-22 (Nov., 1958).

The heat transfer between mutually perpendicular fuel and olant channels of a nuclear reactor is studied for both isotropic d anisotropic conducting media. By means of an electrical nduction analogue, a characteristic length of a unit cell of the actor is experimentally determined for channels of rectangular d circular cross-section. Empirical expressions for this charac-ristic length are given which closely fit the experimental data. A ite difference calculation is used to determine the temperature stribution within a unit cell.

539.17 : 536.2

HEAT CONDUCTION IN INTERNALLY COOLED NUCLEAR ACTORS. See Abstr. 12515

539.17 : 536.2

CONDUCTION HEAT-FLOW TRANSIENTS IN REACTOR ELLS. See Abstr. 12509

539.17 : 536.2

HEAT TRANSFER IN HETEROGENEOUS CIRCULATING-FUEL ACTORS. See Abstr. 12513

539.17 : 536.42

SIMULATION OF TRANSIENT EFFECTS IN WATER COOLED ACTORS. See Abstr. 12535

539.17 : 536.2

13358 REMOVAL OF DECAY HEAT FROM A PLATE-TYPE FUEL SUBASSEMBLY IN THE ATMOSPHERE.

E.Grimble and B.W.LeTourneau.

clear Sci. Engng, Vol. 3, No. 5, 529-39 (May, 1958).

An analysis is made in order to estimate how much heat may removed from a fuel element subassembly in air. The two fol-wing cases are considered: (1) the reactor core as a whole is ex-sed to the atmosphere while the individual subassemblies remain place, (2) the subassembly in question has been removed from e core and is individually exposed to the atmosphere.

539.17 : 536.42

13359 NUCLEATE BOILING CHARACTERISTICS OF ORGANIC REACTOR COOLANTS. D.P.Jordan and G.Leppert.

clear Sci. Engng, Vol. 5, No. 6, 349-58 (June, 1959).

Experimental measurements are reported for nucleate boiling various saturated liquid polyphenyls which are of interest as nu-ear reactor coolants. Heat flux is presented as a function of the ference between the heater surface temperature and saturation nperature, and correlations by various semitheoretical methods e discussed. A peak heat flux is reported for all but one of the uids tested, and good agreement is found with previous work with nilar fluids. Methods are suggested which may be used to esti-ate the nucleate boiling characteristics of these liquids during rced convection at elevated pressures and liquid subcooling, even ough the present tests include only pool boiling studies. These ethods may be used in feasibility analyses of boiling-polyphenyl oled and moderated reactors.

539.17

13360 INTERMEDIATE ENERGY NEUTRON LEAKAGE THROUGH IRON. D.E.Wood.

clear Sci. Engng, Vol. 5, No. 1, 45-8 (Jan., 1959).

Neutron leakage through a reactor shield composed primarily of on is discussed. This is of interest whenever the hydrogen content a shield is reduced either by design requirements or thermal terioration. Work done at several sites on individual aspects of e problem is combined to present and over-all description of the utron streaming. In general there are two different phenomena volved, each determined by the geometry. In the case of a long n streaming path, such as a structural member penetrating the ield, the leakage consists of neutrons which have suffered no llisions. These neutrons will have energies corresponding to ergies at which the iron total cross-section is small. Iron has veral antiresonances in the interval 25 to 100 keV, with the largest dip apparently at 25 keV, so most of the neutron leakage will be at these energies. The other case involves the attenuation of neutrons by large slabs of iron with little or no hydrogen (or other good moderator) present. The 25 keV neutrons are still present, but they are augmented by a large number of neutrons of energy between thermal and 1 MeV. These neutrons may have collided elastically many times but with only a small energy loss each time. Above 1 MeV inelastic scattering suppresses the leakage, and below a few volts, absorption removes the neutrons.

539.17

13361 GAMMA AND NEUTRON HEATING IN AND ABOUT A HOMOGENEOUS REACTOR. R.Fox.

Nuclear Sci. Engng, Vol. 6, No. 1, 33-6 (July, 1959).

A hand calculational procedure used to estimate the gamma and neutron heating in and about a homogeneous reactor core is described. It affords a good insight into the physical processes involved, can handle complex geometries, and is relatively simple to do. One of the interesting results of the gamma heating part of this calculation is the heating of high-Z materials. In an example which is used for a medium-Z element, such as molybdenum, the gamma heating is four times more per unit mass than it is for a substance such as graphite. For higher-Z materials the heating is proportionately greater. One of the interesting results of the neutron heating part of the calculation is the heating of low atomic weight materials. The heating in water from the moderation of fast neutrons, for example, is found to be three times greater than that of the gamma heating.

539.17 : 539.12

13362 APPROXIMATE GAMMA RAY FLUX CALCULATIONS OUTSIDE A REACTOR CORE. M.Roos.

Acta polytech. Scand., Ph. 4 (No. 273/1960), 24 pp.

In the first approximation, a cylindrical core is assumed to be homogeneous and to constitute a cylindrical source of uniform strength. The build-up factor is taken as that given by Taylor (1954). In the second approximation, the true radial J_0 source distribution of the core is replaced by the first few terms of a sine series. Finally, the core is approximated by distributed line sources in a homogeneous medium. The transformation between cylindrical and equivalent-line sources is carried out by both the self-absorption distance and escape probability methods. These approximations were applied to the core of the R3b reactor.

D.H.Lord

539.17

13363 ELECTRONIC ANALOG SIMULATION OF AN IN-PILE CIRCULATING FUEL LOOP.

M.T.Robinson, J.F.Krause, F.P.Green and D.F.Weekes.

Nuclear Sci. Engng, Vol. 3, No. 6, 648-59 (June, 1958).

An electronic analogue is described which has been used to study the thermal behaviour of a small circulating fuel loop intended for in-pile studies of molten fluoride reactor fuels. Results of a typical study are presented.

539.17

13364 EFFECT OF URANIUM RECYCLE ON TRANSURANIC ELEMENT BUILDUP. E.D.Arnold.

Nuclear Sci. Engng, Vol. 3, No. 6, 707-25 (June, 1958).

The buildup of the important transmutation products in irradiated uranium was calculated. Significant quantities of such products are produced upon irradiation with pile neutrons, using an MTR geometrical configuration as reference. These quantities are further increased with subsequent recycle through power reactors. The nuclides are U^{236}, U^{237}, Np^{237} and Pu^{238}. Variables included in this study were: irradiation levels of 6×10^{19} to 3×10^{21} n/cm^2; effect of recycle in the range 1 to 400 cycles and infinite recycle (or steady state); initial fuel enrichment (where applicable) in the range of 0.5-3.0%U^{235}; and the effect of fraction of U^{236} removed by a gaseous diffusion plant reconcentration of U^{235} in the range 0-100% removal. This last variable depends on the operational characteristics of the diffusion plant. The buildup of transmutation products may have many appreciable effects on the design and operation of fuel recycle. The decay time required will increase as a result of higher concentrations of U^{237}; chemical separation plants may be required to separate Np^{237} as well as uranium, plutonium, and fission products; and the buildup of Pu^{238} in the plutonium product may create additional biological or handling problems. An important conclusion of this work is that all problems resulting from isotope buildup in the U^{235} buildup chain may be decreased in seriousness by approximately an order of magnitude with removal of about 25% of the U^{236} by enrichment in a gaseous diffusion plant.

539.17

13365 CRITICAL MEASUREMENTS ON $UO_3-H_3PO_4$ SOLUTIONS.

J.C.Allred, P.J.Bendt and R.E.Peterson.

Nuclear Sci. Engng, Vol. 4, No. 3, 498-500 (Sept., 1958).

During the course of homogeneous reactor fuel studies, critical measurements were carried out with solutions of UO_3 (93.5% U^{235}) dissolved in 4.3 molar H_3PO_4. A brief description of these measurements, their results, and an evaluation of some calculations is presented.

539.17

13366 PLUTONIUM RECYCLE IN THE CALDER HALL TYPE REACTOR.

L.J.Barbieri, J.W.Webster and Ken Tang Chow.

Nuclear Sci. Engng, Vol. 5, No. 2, 105-19 (Feb., 1960).

The economics and physics of plutonium recycle in the Calder Hall type reactor are considered. Three possible schemes of recycle are studied. In scheme A the plutonium produced in a run is blended with fresh natural uranium for a subsequent run; in scheme B the plutonium is alloyed with some diluent metal and fabricated into high heat-transfer elements more like MTR or PWR seed type elements and a subsequent load of fresh natural uranium elements is "spiked" with these plutonium elements; and in scheme C half the spent uranium is recycled as well as the plutonium. The conclusions are that scheme A will be the most economic means of recycle and will compete very favourably with the mode of operation where the plutonium is sold at the end of each run for \$12 per gm. Viewed in another way, with natural uranium having its current value and lease charge, the fuel value of plutonium for recycling, with all costs considered, will be greater than \$12 per gm. Schemes B and C do not look as attractive as A for the Calder Hall type reactor. The results are predicated on the assumption that the fuel elements will withstand exposure levels as high as 8800 MWd/ton. This is beyond present experience but it is believed that it is not unrealistic to assume that such exposures will be achieved in the future with improved fuel elements. A matrix-analytic solution to the differential equations governing isotopic concentrations as functions of flux-time is also developed.

539.17

13367 REACTOR FUEL CYCLE ANALYSIS BY SERIES METHODS.

R.L.Murray, S.A.Hasnain and A.L.Mowery, Jr.

Nuclear Sci. Engng, Vol. 6, No. 1, 18-25 (July, 1959).

An analytical method is developed for determining the properties of a power or converter reactor as a function of time during the operating cycle. Account is taken of the space-dependent fuel consumption and production by the fundamental flux distribution. Average isotopic compositions, reactivity, isotopic power distribution, and cycle life are expressed in terms of "burnup" functions. These may be evaluated by the use of series involving tabulated flux averages over the core.

539.17

13368 CALCULATION OF MTR FUEL LOADINGS.

H.L.McMurry, G.A.Cazier and R.W.Goin.

Nuclear Sci. Engng, Vol. 6, No. 1, 44-8 (July, 1959).

For economical operation of the MTR, mixtures of new and used fuel must be distributed so that the required cycle time is met. An equation is derived which expresses the megawatt days possible from a new fuel charge in terms of the known life of the preceding charge, and the change in the initial fuel loading. The equation takes account of effects arising from differences in the initial U^{235} contents of the fuel assemblies, changes in the equilibrium concentrations of Xe^{135} and Sm^{149} during the run, and production of low cross-section fission poisons. For certain conditions of common occurrence it reduces to a semi-empirical equation which has been used in the past for calculating fuel loadings. The theory can be used to derive equations for the charge life when fuels other than U^{235} are used.

539.17 : 539.3

13369 THERMAL STRESSES IN EXTERNALLY CLAD CYLINDRICAL FUEL ELEMENTS. C.O.Smith.

Nuclear Sci. Engng, Vol. 3, No. 5, 540-7 (May, 1958).

Equations for the thermal stresses developed in externally clad cylindrical fuel elements with radially symmetric temperature distribution are presented. The stresses developed in both a solid and a hollow fuel element under a given set of conditions are calculated and shown as an application of the equations.

539

13370 RADIOLYTIC YIELDS OF NITROGEN AND HYDROGE IN WATER BOILERS.

R.M.Bidwell, L.D.P.King amd W.R.Wykoff.

Nuclear Sci. Engng, Vol. 1, No. 6, 452-4 (Dec., 1956).

Yields of nitrogen and hydrogen from several Water Boiler ur nitrate solutions were measured in the presence of excess oxygen gas. Nitrogen yield increased with increased uranyl nitrate conc tration, but hydrogen yield decreased. The hydrogen yields agree with those obtained by different techniques at the Oak Ridge Natio Laboratory. The nitrogen yield for a uranyl nitrate solution 1.0 in nitrate is 0.004 molecule N_2 per 100 eV.

539

13371 FISSION GAS BEHAVIOUR IN THE URANIUM–ALUMINUM SYSTEM. M.B.Reynolds.

Nuclear Sci. Engng, Vol. 3, No. 4, 428-34 (April, 1958)..

Data on the diffusion of fission krypton from irradiated 20 w U–Al alloy are presented. At temperatures below 640°C (the eutectic) there was no measurable loss of radiokrypton from this alloy during annealing periods of up to three weeks. At temperat above the eutectic gas evolution occurred with a time dependence rough agreement with the theoretical prediction for diffusion fro spherical particles. The nature of the diffusion process for rare gases in metallic systems is discussed with particular reference the limitations imposed on diffusion rate by solubility and availa concentration gradient. The basic difference between the behavio of fission gases in dispersion-type nuclear fuels and in homogene solid-type fuels is outlined. The data on the U–Al alloy system interpreted in light of this discussion.

539.17 : 53

13372 HYDRODYNAMICS OF A LIQUID POISON SCRAM SYSTEM. D.Burgreen.

Nuclear Sci. Engng, Vol. 4, No. 1, 82-95 (July, 1958).

A study is made of the transient motion of a suddenly releas column of liquid poison, such as mercury or borated water, as it moves through the control tubes of a reactor. Two basic system are described. The first system consists of a tank of liquid pois situated above the reactor, connecting directly to control tubes e tending down into the core. The second system is a U-tube arran ment in which the liquid poison enters through tubes that extend upward from the base of the core. By making the tank or standpi diameter larger than the control tube diameter, it is possible to obtain initial fluid column accelerations greater than gravitationa acceleration by a factor equal to the ratio of standpipe area to control tube area. High initial accelerations are inherent feature of liquid poison scram systems. An exploitable feature of the U- system is that the liquid column undergoes a natural rapid decele ation. It may therefore be possible to do away with damping devi that are often required at the base of a solid control rod channel. The equations of motions of the system are derived and integrate The general solution in both cases gives the displacement time explicitly in terms of elliptic functions; in the U-tube system the unconfined fluid column is found to execute uniform elliptic oscillations.

539.17 : 54

13373 DISTRIBUTION AND ELUTION OF FISSION PRODUC UPON ThO_2-UO_3 SLURRY AT SIMULATED REACT CONDITIONS. A.R.Fritsch and B.Levy.

Nuclear Sci. Engng, Vol. 6, No. 2, 97-9 (Aug., 1959).

The adsorption of simulated fission products on slurries of ThO_2-UO_3 mixtures has been studied. Experiments were perfor using tracer techniques employing slurries which had been previ pumped in order that the condition of the slurry as well as conce tration of the fission products, temperature, and pressure might simulate reactor conditions. Results of some preliminary exper ments designed to remove fission products by the use of eluting agents are also reported.

53

13374 THE GENERAL THEORY OF CONTROL SHEETS. B.Wolfe.

Nuclear Sci. Engng, Vol. 4, No. 5, 635-48 (Nov., 1958).

A general approach to the problem of evaluating the effectiv ness in a reactor of plane control sheets is described. A formal expression for the critical equation of a reactor containing plane parallel control sheets is derived under very general conditions. The expression is simplified for cases of practical interest whe sheet spacing is large compared to the smaller of L (neutron fusion length) or $\tau^{1/2}$ (root of neutron age). With this limitation, plicit and easily soluble critical equations are derived for rmally black control sheets in a number of interesting arrangents. In particular, the critical equation for a rectangular rallelepiped reactor containing an arbitrary number of equally aced control sheets placed anywhere in the reactor core is written easily soluble form. Extension of the techniques to more complied situations is discussed.

539.17

13375 PERTURBATION THEORY OF CONTROL ELEMENTS. I.

B.Wolfe and D.L.Fischer.

clear Sci. Engng, Vol. 4, No. 6, 785-93 (Dec., 1958).

An exact expression for the reactivity effect of a control element aced in a reactor is derived within the limitation of validity of ltigroup diffusion theory. The evaluation of the expression requis a knowledge of the flux distributions in the reactor with and hout the elements inserted. Since the reactivity effect is stated terms of the flux distribution in the perturbed and unperturbed actors, one can calculate the effect of a control element if a good imate for the form of the perturbed flux is made. A first-order rturbation calculation for thermally black control elements is esented. The perturbation calculation assumes that the fast flux unaffected by the presence of the control element. The results valid for a reactor in which the neutron age is large compared the square of the thermal diffusion length and for a control ment which is small compared to both the size of the reactor and square root of the age.

539.17

13376 PERTURBATION THEORY OF CONTROL ELEMENTS. II.

B.Wolfe and D.L.Fischer.

clear Sci. Engng, Vol. 5, No. 1, 5-10 (Jan., 1959).

The perturbation approach to control element evaluation is ended from previous work (see preceding abstract). A two-group cond-order perturbation expression for control element worth is ained. This has, as its starting point, the unperturbed fast flux considers the depression in the thermal flux caused by the control ment and then, in turn, considers the perturbation on the fast flux used by the perturbed thermal flux. Finally, the effect of the perturbed t flux on the thermal flux is evaluated. It is shown that this process, if ntinued, converges to the correct answer. The perturbation results compared to experiments for the case of a weak rod in the flector region of the Bulk Shielding Reactor. The perturbation sults are also compared to exact two-group calculations for a lindrical rod on the axis of a bare cylindrical reactor. In both ses, excellent agreement is obtained.

539.17

13377 RELATIVE CONTROL ROD WORTHS OF SOME RARE EARTH OXIDES.

F.Johnston, J.L.Russell, Jr and W.L.Silvernail.

clear Sci. Engng, Vol. 6, No. 2, 93-6 (Aug., 1959).

In order to determine the relative merits of the various rare rths as reactor control materials, a series of relative worth asurements was made in the Dresden Critical Assembly at llecitos Atomic Laboratory. Combinations of the oxides of five re earths with highest thermal cross-sections (dysprosium, bium, europium, gadolinium, and samarium) were compared with dmium and 2% boron steel. Dy_2O_3, Gd_2O_3, and Sm_2O_3, separately d in combination, were found to be roughly equivalent in worth. $_2O_3$ was found to be the strongest absorber. Er_2O_3 was found to much less effective than the other materials studied.

539.17

13378 EPITHERMAL HAFNIUM PARAMETERS FOR THE CALCULATION OF CONTROL ROD WORTH IN IERMAL REACTORS.

T.F.Ruane and M.L.Storm.

clear Sci. Engng, Vol. 6, No. 2, 119-27 (Aug., 1959).

The average epithermal nonabsorption probability ($\bar{P}_2$) for fnium slabs is calculated by two different methods: (1) Within the amework of a specific two-dimensional, three-energy-group callational scheme, an empirical value of $\bar{P}_2$ is determined which gives reement with experimental rod worths. (2) Based on available croscopic cross-section data for the hafnium isotopes, the value $\bar{P}_2$ is calculated and compared with the empirical value obtained ove. The values of $\bar{P}_2$ obtained by these different methods for in. and 0.2 in. thick slabs agree to within 10 per cent, thus vering the physical reasonablesness of the empirical probabilities.

539.17

13379 VARIATIONAL CALCULATION OF CONTROL ROD REACTIVITY.

E.P.Gyftopoulos and L.de Sobrino.

Nuclear Sci. Engng, Vol. 6, No. 2, 135-9 (Aug., 1959).

The reactivity worth of cylindrical control rods of small cross section inserted in a cylindrical reactor is evaluated by means of a variational method. Both one-group and two-group diffusion theory are used and simple formulae are developed for a single eccentric and a concentric array of control rods. The results obtained are illustrated by means of a numerical example and compared to the results derived from other methods available in the literature.

539.17

13380 THE EBR-I MELTDOWN — PHYSICAL AND METALLURGICAL CHANGES IN THE CORE.

J.H.Kittel, M.Novick and R.F.Buchanan.

Nuclear Sci. Engng, Vol. 4, No. 2, 180-99 (Aug., 1958).

As a result of the partial meltdown which occurred in EBR-I on November 29, 1955, it was necessary to remove the core assembly from the reactor and to separate the enriched fuel section from upper and lower unenriched blanket sections. A temporary cave was constructed on top of the reactor in order to remove the core assembly, and at this time about one-fourth of the fuel elements were removed. In order to perform further disassembly operations under less hazardous conditions, the core assembly was shipped from the Idaho Division of Argonne National Laboratory, at the National Reactor Testing Station, to the Lemont, Illinois, site of the Laboratory where disassembly was completed in a protective atmosphere. It was found that about 40 to 50% of the core had melted and reached temperatures ranging between approximately 860° and 1400° C, and that the molten portion had separated into three clearly defined zones characterized by different porosities. Densities of the zones ranged from 2.5 to 15.4 g/cm^3, depending upon the degree of porosity. Chemical and mass spectrographic analyses indicated that relatively little mixing occurred in the core during the period in which it was molten, that the fuel alloy which penetrated the blanket sections originated primarily from the outer part of the molten zone, and that the blanket did not enter the molten phase. Observations during disassembly of the core and subsequent simulated meltdown experiments indicated that the porous structure which formed in the molten core could have resulted from the vaporization of entrained NaK.

539.17 : 539.12

13381 DELAYED-NEUTRON MONITORS FOR THE DETECTION OF SHEATH FAILURES IN REACTOR FUEL RODS.

C.H.Millar, B.W.Sargent and J.C.Horsman.

Nuclear Sci. Engng, Vol. 2, No. 3, 363-72 (May, 1957).

Development is described of a device (using a $B^{10}F_3$ proportional counter) to detect holes in the fuel-rod sheaths in an H_2O-cooled heterogeneous reactor by detecting delayed-neutrons from fission products in the effluent coolant. Operational comparison with other types of monitors is tabulated for 22 cases of burst rod sheaths. Modifications required to adapt the monitor to a D_2O-cooled reactor are discussed.

539.17 : 539.1.07 : 621-52 : 621.317.7

13382 INSTRUMENTATION FOR A SUBCRITICAL HOMOGENEOUS SUSPENSION REACTOR.

I. REASONS BEHIND THE CHOICE OF A HOMOGENEOUS SUSPENSION REACTOR. J.J Went.

II. MEASUREMENT AND CONTROL OF OPERATING PARAMETERS. B.L.A.Van der Schee and M.van Tol.

IIIA. THE MONITORING OF LOW NEUTRON FLUX BY MEANS OF FAST PULSE-COUNTING CHANNELS. J.J.van Zolingen.

IIIB. THE MONITORING OF HIGH NEUTRON FLUX WITH THE AID OF AN ELECTROMETER. M.van Tol.

IV. THE SAFETY CIRCUITS. F.J.Schijff.

Philips tech. Rev., Vol. 21, No. 4-5, 109-21, 121-33, 134-44, 144-7, 148-53 (1959-60).

539.17 : 537.56

13383 MAGNETIC CONFINEMENT OF THERMONUCLEAR REACTIONS

A.V.J.Martin and F.J.Young.

J. Phys. Radium, Vol. 20, Suppl. No. 4, 1A-4A (April, 1959).
In French.

Some of the difficulties inherent to the large scale release of fusion energy are discussed. In particular, the problem of containing a thermonuclear plasma is investigated. A method of doubling the effectiveness of magnetic confinement is devised. The accuracy of previous pinch effect investigations is also discussed.

539.17

13384 GENERAL PROBLEMS OF THE CONTROLLED THERMONUCLEAR PROCESS. E.Teller.

Nuclear Sci. Engng, Vol. 1, No. 4, 313-24 (Aug., 1956).

Thermonuclear reactions under steady-state conditions are considered in order-of-magnitude terms. Energy loss by radiation and the transfer of energy between nuclei and electrons are also discussed. It is pointed out that the principal problem is constructing a suitable "magnetic bottle" in which nuclei of a dilute, completely ionized gas (e.g., H^2, H^3) at a temperature $\sim 10^8$ °K can be confined and reacted before losing too much energy to the walls. The practical confinement of the plasma, involving substantial hydromagnetic difficulties, can probably be accomplished, although it appears to be perhaps decades in the future. Potential advantages of a thermonuclear reactor over a fission reactor include: virtually inexhaustible fuel supply available, fuel reprocessing unnecessary, no chain reaction run-away hazard present, and direct conversion of thermonuclear energy to electrical energy may be possible.

539.17

13385 STUDIES OF PLASMA HEATED IN A FAST-RISING AXIAL MAGNETIC FIELD (SCYLLA).

K.Boyer, W.C.Elmore, E.M.Little, W.E.Quinn and J.L.Tuck.
Phys. Rev., Vol. 119, No. 3, 831-43 (Aug. 1, 1960).

The Scylla plasma experiment, which employs a rapidly rising magnetic field in a cylindrical mirror geometry to produce and heat a deuterium plasma, is described. Experimental studies of the reproducible neutron emission from the hot plasma show that the neutrons are emitted (1) in a symmetrical, bell-shaped time distribution centred on the maximum of the magnetic field, (2) from a limited region with a 2 cm axial length and a 1.5 cm diameter centred in the compression coil, and (3) in the radial direction with a narrow spread of energies and no significant anisotropy. The time distribution of the neutron emission is shown to be in agreement with a thermonuclear yield curve calculated for an adiabatic compression by the observed magnetic field. The neutron yield has been studied as a function of deuterium pressure, capacitor-bank voltage, and nitrogen impurity. Observations of the space-time distribution of the visible light emission with a streak camera show that (1) a strong radial "shock" occurs at the beginning of the second half-cycle, (2) very little light is emitted from the plasma "fireball" during the time of neutron emission, and (3) an intense luminous flux is produced during the later stages of the discharge. The energy absorbed in each half-cycle of the discharge by the gas is presented as calculated from the incremental damping of the driving magnetic field. Observations of hard X-ray emission (~ 200 keV) at times of maximum dB/dt for operating pressures in the 5 to 50 micron range are contrasted with the characteristics of the neutron emission in regard to time distribution, pressure, impurities, and r.f. pre-excitation. Magnetic probe studies of the Scylla discharge are reported and evidence is given that the perturbing effects of the probe dominate the plasma temperature. See also following two abstracts.

539.17

13386 CONTINUUM RADIATION IN THE X-RAY AND VISIBLE REGIONS FROM A MAGNETICALLY COMPRESSED PLASMA (SCYLLA).

F.C.Jahoda, E.M.Little, W.E.Quinn, G.A.Sawyer and T.F.Stratton.
Phys. Rev., Vol. 119, No. 3, 843-56 (Aug. 1, 1960).

The identification of a sharp low-wavelength cutoff in the spectrum of X-rays emitted from deuterium discharges in Scylla has resulted in the assignment of an electron temperature of 240 ± 40 eV at the time of peak magnetic field compression. Simultaneous time-resolved absolute intensity determinations in the visible continuum, when coupled with the temperature measurement, yield an upper limit electron number density of $(5 \pm 1) \times 10^{16}/\mathrm{cm}^3$ at peak compression. The absolute value of $dE/d\lambda$ in the soft X-ray region is 200 times larger than bremsstrahlung from a pure deuterium plasma at the temperature and density quoted, and it is postulated that the large experimental $dE/d\lambda$ is the result of recombination radiation from about 2% of oxygen contaminant from the discharge tube walls.

539.17

13387 VELOCITY SPECTRUM OF PROTONS AND TRITONS FROM THE d—d REACTION IN SCYLLA.

D.E.Nagle, W.E.Quinn, F.L.Ribe and W.B.Riesenfeld.
Phys. Rev., Vol. 119, No. 3, 857-62 (Aug. 1, 1960).

A diagnostic experiment was carried out on the d—d reactions produced by fast magnetic compression of a deuterium plasma.
determination of the velocity spectra of protons and of tritons fro
the d—d reaction was made by magnetic analysis and nuclear plat
detection of the particles. The observed distributions are Gaussi
with widths which correspond to a deuteron temperature of 1.3 ke
Comparison of the mean proton and triton momenta indicates that
no plasma drift in the (axial) direction of observation is present,
any potential difference between the source plasma and detector
greater than a few volts. These results, coupled with previous o
on the neutron yield, duration, source extent, and lack of circumferential drift, argue against any of the simple, physically plausi
non-Maxwellian acceleration mechanisms for the d—d reactions
far proposed.

ATOMS

539

13388 THE PRESSURE DEPENDENCE OF THE DISTRIBUT OF ORBIT-ANGULAR-MOMENTUM OF ELECTRON ATOMS. P.Gombás.

Acta phys. Hungar., Vol. 7, No. 3, 365-71 (1957). In German.

This problem is discussed using the Thomas—Fermi statis
model. It is shown that, in the case of argon, xenon and radon, a
pressures greater than 10^{14} dyne/cm^2, angular momentum states
which are normally empty become occupied. T.E.Peac

539

13389 THE CALCULATION OF DIAMAGNETIC SUSCEPTIBILITIES OF FREE CATIONS. C.Courty.

C.R. Acad. Sci. (Paris), Vol. 250, No. 20, 3293-5 (May 16, 1960). In French.

By taking shielding effects and the increase in atomic numbe
due to ionization into account, a method of calculating diamagneti
susceptibilities of free cations is outlined.

W.J.Orville-Tho

53

13390 RELATION BETWEEN THE PARABOLIC AND SPHERICAL EIGENFUNCTIONS OF HYDROGEN.

D.Park.
Z. Phys., Vol. 159, No. 2, 155-7 (1960).

It is shown that the transformation coefficients relating the
functions of the Kepler problem in parabolic and spherical coord
respectively, are the normalized Clebsch—Gordan coefficients.

53

13391 ATOMIC LEVEL ENERGIES IN RARE EARTH ELEMENTS. P.Bergvall and S.Hagström.

Ark. Fys., Vol. 17, Paper 2, 61-79 (1960).

The L_I, L_{II} and L_{III} level energies have been measured in t
oxides of stable rare earth elements ($57 \leq Z \leq 60$, $62 \leq Z \leq 71$),
ploying the photo electron method. The $L_{II}-L_{III}$ energy differen
are found to agree within 0.5 eV with the $K\alpha_1-\alpha_2$ X-ray emissio
energy differences. A comparison with theoretical predictions
also made, and the possibility of a quantitative estimate of nucle
size effects on the fine structure is discussed. The L levels and
K level (obtained by addition of the $K\alpha$ lines) are compared with
from X-ray absorption spectroscopy, showing systematic discre
cies especially for the L_I level.

539

13392 APPROXIMATE WAVE FUNCTIONS FOR ATOMIC B R.E.Watson.

Phys. Rev., Vol. 119, No. 1, 170-7 (July 1, 1960).

A configuration interaction calculation, involving thirty-seve
configurations and including the $(1s)^2(2s)^2$ Hartree—Fock functio
has been performed for the ground state of atomic Be. Approximately 90% of the correlation energy has been incorporated into
final total energy. The results indicate that the correlation ener
is associated with two effects, namely that of the "correlation ho
as has been observed for He and that of "orbital degeneracy" (w
does not appear in the two-electron He case). The former effect
best handled by the Hylleraas approach and the latter by the con
ration interaction method, and the results suggest that an admix
of the two methods would lead to the most rapidly convergent description of the exact four-electron wave-function. The errors

ced by handling "high-lying" configurations by second-order per-bation theory rather than by exact configuration interaction are so investigated.

539.18 : 535.33

EXCITATION OF Xe BY HIGH FREQUENCY PULSES. See str. 12479

539.18 : 539.14

13393 THE NUCLEAR COMPRESSIBILITY FROM ISOTOPE SHIFT DATA. N.J.Ionesco-Pallas.

ovo Cimento, Vol. 15, No. 3, 323-33 (Feb. 1, 1960).

A general theory is given of isotope shift in heavy atoms taking to account the nuclear specific effects as well as those due to ectronic shells. Only the "odd staggering" effect is not considered ing to the particular choice of even—even nuclei. The problem resolved rigorously under the assumption that the proton distri-tion in nuclei is that of Fermi. For the computation of compres-bility the model of Wilets with some modification is used. The scussion of results for a wide range of mass numbers — including e high nuclear deformation region — leads to the need of the hnson—Teller effect and to a value for compressibility of about MeV.

539.18

13394 EXPERIMENTAL VERIFICATION OF THE "INCOHERENT SCATTERING" THEORY FOR THE TRANSPORT F RESONANCE RADIATION. A.V.Phelps and A.O.McCoubrey.

ys. Rev., Vol. 118, No. 6, 1561-5 (June 15, 1960).

The predictions of the incoherent scattering theory of the trans-rt of resonance radiation developed by Holstein and by Biberman e shown to agree with laboratory measurements of the decay con-ants for the intensity of the mercury 2537 A resonance radiation llowing a period of optical excitation. Also, the relative import-ce of the diffusion of resonance atoms and the escape of resonance diation as mechanisms for the destruction of mercury atoms in the $_1$ or resonance state are determined from measurements of decay nstants as a function of mercury density and cell radius. The ex-rimental results show that diffusion of the resonance atoms is gligible and that the predictions of imprisonment theory are con-rmed to within 15%. The experiments sets an upper limit to the ffusion coefficient at unit gas density for atoms in the $^3P_1$ state of × 10^{17} cm^{-1} sec^{-1} at 340°K, which is consistent with a value of × 10^{16} cm^{-1} sec^{-1} predicted using the frequency of excitation trans-r collisions calculated by Holstein. The success of the theories sed on completely incoherent scattering of resonance radiation ints to the desirability of including this feature in the treatment those astrophysical problems in which the spectral line shape is termined by Doppler broadening or by collisions broadening.

539.18

13395 ISOTOPIC COMPOSITION OF POTASSIUM. B.R.F.Kendall.

ature (London), Vol. 186, 225-6 (April 16, 1960).

Results are given of the determination of the isotopic compo-ition of potassium in natural samples. The survey was carried t in two parts: fifty K^{39}/K^{41} analyses were made of twenty-seven ifferent samples; and twenty K^{41}/K^{40} analyses were made on fifteen ifferent samples. Each group of samples included minerals, nor-al and cancerous human tissues, embryonic tissues, Indian Ocean ea water, two tektites, and one plant sample. The analyses were arried out with a 60°, first-order single-focussing mass spectro-eter with a 14 cm ion path radius. The values obtained for the ean ratios $K^{39}:K^{41}$ and $K^{41}:K^{40}$ in the ion beams reaching the mass pectrometer ion collectors from standard samples were 3.77 ± 0.03 and 576 ± 3 respectively. (The errors are probable rrors). The normal ratios obtained for human tissue suggest that laims of abnormal radioactivity of potassium from organic sources ay be due to the presence of impurities in the sample materials. he fact that none of the samples showed a significant difference in ither ratio means that the assumption of constant K^{40} relative bundance, widely employed in the potassium-argon dating method, probably valid within very small limits, at least in the case of rrestrial samples. The experimental technique and calibration ethods are fully discussed. C.F.Barnaby

539.18 : 539.14

13396 THE EXISTENCE OF NEW ISOTOPES OF LIGHT NUCLEI AND THE STATE EQUATION OF NEUTRONS. a.B.Zel'dovich.

h. eksper. teor. Fiz., Vol. 38, No. 4, 1123-31 (April, 1960). Russian.

The limits of stability (relative to nucleon emission) of light nuclei are considered. The existence (in the sense of stability with respect to decay with nucleon emission) of the following nuclei is predicted: He^8, Be^{12}, O^{13}, B^{15},^{17},^{19}, C^{16-20}, N^{18-21}, Mg^{20}. The possibility of existence of heavy nuclei consisting of neutrons only is considered. This problem is reduced to a Fermi gas with resonance interaction of the particles. The energy of such a gas is proportional to $\omega^{2/3}$, where ω is its density. Accuracy of the calculations is not sufficient for determination of the sign of the energy and for solving the physical problem concerning neutron nuclei.

539.18

13397 URANIUM ISOTOPE SEPARATION BY NOZZLES. M.Levoy.

Nucleonics, Vol. 18, No. 4, 68-70,118 (April, 1960).

A gaseous mixture of isotopes is fed under pressure through a nozzle from which the gas emerges as an expanding supersonic jet. The heavier component is more concentrated in the core region and is separated by a suitable collector. The article reviews work in nozzle design and the effects of pressure in the jet and exhaust region. The application of the method to the separation of UF^6 is discussed and a bibliography included. R.D.Smith

539.18 : 537.534

THE MAGNETO-IONIC EXPANDER ISOTOPE SEPARATOR APPLIED TO URANIUM. See Abstr. 12652

539.18 : 545

ISOTOPE RATIO OF NATURAL URANIUM. See Abstr. 12124

539.18

13398 FORM FACTOR FOR THE EJECTION OF ELECTRONS FROM THE L-SUBSHELLS BY PROTONS. M.V.Mihailović.

"J. Stefan" Inst. Rep., Vol. 3, 55-60 (Oct., 1956).

Expressions for the above form factor are derived, assuming the Born approximation for the bombarding proton, and using spherical coordinates.

539.18

13399 EFFECT OF MUTUAL DISTORTION ON PHASE SHIFTS OF COLLIDING SYSTEMS. I.C.Percival.

Phys. Rev., Vol. 119, No. 1, 159-64 (July 1, 1960).

The box variational principle for scattering phase shifts (Abstr. 6894 of 1957) is extended to one channel collisions of arbitrary angular momentum without exchange, and also to systems with many degrees of freedom, when the energies are nonrelativistic and insufficient to produce inelastic collisions. Under reasonable assumptions of continuity it is proved that the commonly used one state and many-state approximations always reduce the scattering phase shift from its correct value, so long as no further approximations have to be made, and thus provide lower bounds to the exact scattering phase shift. The distorted wave approximation is an example. The inclusion of more states into a many-state approximation never makes the estimated phase any worse, and generally improves it. Mutual distortion of colliding systems never reduces the phase shift and generally increases it, thus producing an effective attraction between the systems.

539.18

13400 COLLISION PROCESSES IN MIXTURES OF MERCURY VAPOR AND FOREIGN GASES. D.E.Cunningham and L.O.Olsen.

An extensive and quantitative study of collision processes occurring in mercury vapour—foreign gas mixtures was performed. Measurement of the polarization of mercury resonance radiation allows a determination of the probability for quenching, adiabatic depolarizing, and nonadiabatic depolarizing collisions. The use of a photomultiplier circuit in securing the data, and of an IBM 610 computer in its analysis, made the breadth of this study possible. The most important result is that no adiabatic depolarization is needed to account for the results obtained for all foreign gases studied. All quenching and depolarizing probabilities obtained in this and in earlier studies are summarized in tabular form.

539.18

13401 DISPERSION RELATIONS IN ATOMIC SCATTERING PROBLEMS. E.Gerjuoy and N.A.Krall.

Phys. Rev., Vol. 119, No. 2, 705-11 (July 15, 1960).

Dispersion relations appropriate to the scattering of electrons by hydrogen atoms are deduced, and applied to actual measurements in the 0-10 eV energy range. Two such experiments exist, yielding quite different results. Dispersion relations indicate that only certain angular distributions at low energy are consistent with these low-energy total cross-section measurements; this suggests experiments which could be used as checks on the accuracy of the existing measurements.

539.18

13402 ON THE INCLUSION OF EXCHANGE IN THE THEORY OF COLLISIONS. R.K.Peterkop.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1172-3 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 834-5 (April, 1960).

Criticism of the work of Drukarev (Abstr. 1918 of 1957) on the scattering of electrons by atoms (as applied to H atoms) on the ground that Drukarev did not consider the flux produced by the functions of the continuous spectra, the exchange term in which is responsible for the difference between cross-sections for different spins. J.Hawgood

539.18

13403 BORN CROSS SECTIONS FOR INELASTIC SCATTERING OF ELECTRONS BY HYDROGEN ATOMS. I. 3s, 3p, 3d STATES. G.C.McCoyd, S.N.Milford and J.J.Wahl.

Phys. Rev., Vol. 119, No. 1, 149-53 (July 1, 1960).

Born cross-sections of all n = 3 to n = 4 transitions are calculated at ten incident electron energy values in the range 0.67-1400 eV, and those of strong optically allowed n = 3 to n = 5 transitions are calculated at five incident electron energy values in the range 1-10 000 eV. The cross-sections obtained are much larger than for comparable transitions from the ground state, and the cross-sections for transitions which are optically allowed and in which n and l change in the same sense are larger than those for other transitions. For all strong optically allowed transitions the Bethe (dipole) approximations to the Born cross-sections are calculated and comparison shows that the Bethe formula gives a good fit to the Born approximation down to relatively low energies (~10 eV).

539.18

13404 BORN CROSS SECTIONS FOR INELASTIC SCATTERING OF ELECTRONS BY HYDROGEN ATOMS. II. 4s, 4p, 4d, 4f STATES. L.Fisher, S.N.Milford and F.R.Pomilla.

Phys. Rev., Vol. 119, No. 1, 153-5 (July 1, 1960).

The Born total cross sections are calculated for the inelastic scattering of electrons by hydrogen atoms for the strong optically allowed transitions from n = 4 to n' = 5. The nine incident energies considered range from 0.546 to 1361 eV. In addition, the 4s to 6p and 4f to 6g transitions are considered. Bethe (multipole) cross-sections are also calculated and found to reproduce the Born results down to low energies.

539.18

13405 UPPER BOUNDS ON ELECTRON—ATOMIC HYDROGEN SCATTERING LENGTHS.

I.Rosenberg, I.Spruch and T.F.O'Malley.

Phys. Rev., Vol. 119, No. 1, 164-70 (July 1, 1960).

Recently developed variational techniques for determining upper bounds on scattering lengths are applied to singlet and triplet scattering of zero-energy electrons by atomic hydrogen. The results obtained are not only rigorous but are in fact somewhat lower and therefore somewhat better than those previously obtained by variational methods. It is found that the triplet and singlet scattering lengths, A_T and A_S respectively, satisfy the inequalities $A_T \leq 1.91a_0$ and $A_S \leq 6.23a_0$, where a_0 is the Bohr radius. The only assumptions involved in the deduction of these results are that there are no bound triplet state and one and only one bound singlet state. The singlet trial function determined during the course of the calculation generates a singlet effective range, r_{0S}, of about $2.7a_0$. The triplet trial functions which were obtained were not sufficiently accurate to be useful in a determination of the triplet effective range, r_{0T}.

539.18

13406 NONADIABATIC THEORY OF THE SCATTERING OF ELECTRONS FROM HYDROGEN. A.Temkin.

Phys. Rev. Letters, Vol. 4, No. 11, 566-8 (June 1, 1960).

A rigorous series is developed for the phase shift in the scattering of electrons from atomic hydrogen. The series is rapidly convergent and so allows reliable calculation of the phase shifts. It is similar to an adiabatic series for the same problem, indicating the qualitative validity of the adiabatic assumption. Bot series give values of the singlet and triplet scattering lengths abo the limits calculated by Rosenberg, Spruch and O'Malley (see preceding abstract) on the assumption that the hydrogen ion has on one bound state with singlet spin. A.Ashmo

539

13407 RESONANT ELECTRON CAPTURE AND STRIPPING MODERATELY LARGE-ANGLE ATOMIC COLLISION

F.P.Ziemba, G.J.Lockwood, G.H.Morgan and E.Everhart.

Phys. Rev., Vol. 118, No. 6, 1552-61 (June 15, 1960).

Reports a study of differential scattering of ions by atoms in energy range of 1 to 200 keV. The incident ion, after a single coll sion which is hard enough to result in a 5° deflection, was analyse to determine whether it had captured or lost electrons. The angle 5° was chosen as a typical moderately large angle and held fixed as the energy of the incident ion was varied. When the electron capture probability is plotted versus energy, one or more peaks a observed. For the symmetrical case of He^+ on He, seven peaks a clearly outlined. Four peaks appear in the H^+ on He combination and three with H^+ on H_2. Single or double peaks are found in other cases studied which include H^+ on N_2, O_2, air, Ne, A, and Kr; H_2^+ o H_2 and He; H_3^+ on H_2 and He; He^+ on H_2 Ne, A, and Kr; N^+ on A; N_2 on N_2; Ne^+ on Ne and A; Ne^{++} on Ne and A; A^+ on A; and Kr^+ on K For each case the probabilities for electron capture, scattering w out change of charge, and various degrees of electron stripping ar plotted versus energy. In those cases in which the electron captur probability curve has more than two peaks, these peaks are nearly evenly spaced when the probabilities are plotted versus the time o the interaction. This indicates an electron exchange effect whose period is of the order of 10^{-16} sec. In cases where there are many electrons involved in the colliding atoms the phenomenon is more complicated, but vestiges of this resonant exchange are sometime observed.

539.

13408 IONIZATION AND CHARGE TRANSFER IN PROTON—HYDROGEN ATOM COLLISIONS.

W.L.Fite, R.F.Stebbings, D.G.Hummer and R.T.Brackmann.

Phys. Rev., Vol. 119, 663-8 (July 15, 1960).

The cross-sections for charge transfer and for ionization in collisions between protons and hydrogen atoms were determined over the energy range from 400 to 40 000 eV. The experiment use modulated crossed-beam techniques. Experimental results are co pared with several theoretical predictions.

539.

13409 CHARGE TRANSFER AND ELECTRON PRODUCTION IN H^- + H COLLISIONS.

D.G.Hummer, R.F.Stebbings, W.L.Fite and L.M.Branscomb.

Phys. Rev., Vol. 119, No. 2, 668-70 (July 15, 1960).

The cross-sections for charge transfer and electron producti in collisions between hydrogen atoms and hydrogen negative ions (H^-) were measured over the energy range 100 to 40 000 eV using modulated atomic-beam techniques in a crossed-beam experiment Agreement of the experimental results with the perturbed-stationa states calculation for charge transfer of Dalgarno and McDowell is quite satisfactory. See also Abstr. 5278 of 1960.

539.

13410 REVISED TERM VALUES OF Ti I.

C.C.Kiess and M.P.Thekaekara.

Astrophys. J., Vol. 130, No. 3, 1003-7 (Nov., 1959).

Accurate term values of the first spectrum of titanium are re quired for identification of many of the hitherto unclassified faint lines of the solar spectrum. The application of Edlen's formula fo the refractive index of air gives new term values which are signifi cantly different from older values published in the literature. A semi-automatic method has been developed for deriving term valu from wave lengths by the use of a small electronic computer. The method has been used for a revision of the term values of Ti I fro wave lengths measured interferometrically by Kiess. Term value of 152 levels are presented along with a discussion of their relativ accuracy.

539.

13411 NOTE ON THE HYPERFINE STRUCTURE OF THE $2s^22p\,^2P_{\frac{1}{2}}$ STATE OF BORON 10 AND 11.

H.Lew and R.S.Title.

Canad. J. Phys., Vol. 38, No. 6, 868-71 (June, 1960).

More precise h.f.s. experiments show that there is no signific fference between the values for the ratio of the nuclear g-factors und by hyperfine structure determination and by the nuclear sonance experiments of Abstr. 6215 of 1958. J.Hawgood

539.18

13412 THE EMISSION PROCESS IN THE PHOSPHORESCENCE OF ARGON. L.Herman, J.Séguier and R.Herman.
Phys. Radium, Vol. 19, No. 4, 463-74 (April, 1958). In French.

The intensity change in the afterglow emission spectrum in rgon has been measured using a rotating mirror spectrograph. he intermolecular Stark effect broadening of spectral lines has een used to measure the rate of the electron decay and the radiative ecombination coefficients of a number of CuI lines. The results r different pressures so far obtained are discussed and compared ith existing tentative interpretations of the very high values of the ross sections found for the capture of electrons by molecular ions.

539.18 : 539.14

HYPERFINE STRUCTURE SPLITTING OF THE $^4F_{9/2}$ GROUND TATE IN THE Co^{59} I SPECTRUM. See Abstr. 13121

539.18

13413 HYPERFINE STRUCTURE OF THE 6 $^3P_2$ STATE OF $_{80}Hg^{199}$ AND $_{80}Hg^{201}$. PROPERTIES OF METASTABLE TATES OF MERCURY. M.N.McDermott and W.L.Lichten.
hys. Rev., Vol. 119, No. 1, 134-43 (July 1, 1960).

The hyperfine structures of the metastable 6 $^3P_2$ state of Hg^{199} and of g^{201} were measured by means of the atomic-beam magnetic resonance chnique. The present experiment is the first one for which the ectron bombardment method has been used in the production of a arrowly collimated beam of metastable atoms. The beam was etected by surface ejection of electrons from an alkali metal surface. he zero magnetic field intervals $f(F \leftrightarrow F')$ are: for Hg^{199} $5/2 \leftrightarrow 3/2) = 22\,666.559(5)$ Mc/s; and for Hg^{201} $f(7/2 \leftrightarrow 5/2) =$ $382.6288(8)$ Mc/s, $f(5/2 \leftrightarrow 3/2) = 8629.5218(5)$ Mc/s and $3/2 \rightarrow 1/2) = 5377.4918(20)$ Mc/s. The values of the quadrupole d octupole moments of Hg^{201} are, without polarization corrections, $= 0.50(4) \times 10^{-24}$ cm^2 and $\Omega = 0.13$ nuclear magneton barn. The perfine structure anomaly for the two isotopes due to the s electron one is $\Delta(s_{1/2}) = -0.1728(12)\%$ in disagreement with the predictions the single-particle model. The g_J values for the $^3P_2$ state and the $d^9 6s^2 6p)\,^3D_3$ state were found to be $g_J\,(^3P_2) = 1.50099(10)$ and $(^3D_3) = 1.0867(5)$. The value of J = 3 for the $^3D_3$ state was conrmed. A new technique for obtaining excitation functions is scussed.

539.18

13414 Q CORRECTION IN THE SPECTRA OF THE IRON GROUP. G.Racah and Y.Shadmi.
hys. Rev., Vol. 119, No. 1, 156-8 (July 1, 1960).

A semiempirical correction term, proportional to the "seniority perator" Q, is introduced into the Slater formulae for the configuraons $3d^n 4s^k$ of the second spectra of V, Cr, and Fe. The agreeent with the experimental data, obtained by least squares, is nproved by about 20%. The physical meaning of this correction is scussed.

539.18

13415 OPTICAL PUMPING OF HELIUM IN THE $^3S_1$ METASTABLE STATE. F.D.Colegrove and P.A.Franken.
hys. Rev., Vol. 119, No. 2, 680-90 (July 15, 1960).

For previous work, see Abstr. 722 of 1959. The alignment of e^4 atoms in the (n = 2, metastable) $^3S_1$ state is described. Metatable atoms are produced by an r.f. discharge in a glass tube conining a few mm of pure helium, and the 1 μ pumping light $2\,^3P - 2\,^3S$) is provided by a helium lamp. A resonance signal is btained from radio frequency disorientation by monitoring the ransmitted pumping light. The double maximum line shape of this ignal for strong r.f. magnetic fields is discussed. Included also a discussion of the angular dependence of the signal when unolarized light is used and an explanation of the inversion of the reonance signal for certain densities of the metastable helium atoms. he measured relaxation time of the oriented metastable atoms in e discharge is about 2.5×10^{-4} sec and the pumping time is 1 m sec. A method is proposed and initial measurements are iven for the cross-section for destruction of metastable helium toms by collision with foreign gas atoms. The application of optial pumping in helium to the measurement of weak magnetic fields also discussed.

539.18

13416 PRESSURE BROADENING OF THE VIOLET TRIPLET OF MANGANESE IN THE PRESENCE OF ARGON AND HELIUM. Shang-Yi Ch'en and R.B.Bennett.
Phys. Rev., Vol. 119, No. 3, 1029-31 (Aug. 1, 1960).

The λ4030 triplet of Mn ($3d^5 4s^2$, $^6S - 3d^5 4s4p$, $^6P^0$) was studied in absorption under various pressures of argon and helium ranging in relative density from 1 to 30. Helium produced no shift while argon produced a linear red shift of 0.12 cm^{-1}/r.d. In the presence of both helium and argon, the half-widths were found to increase directly with increasing relative density of the perturbing gas. The $j = \frac{3}{2}$, $\frac{5}{2}$ and $\frac{7}{2}$ components are broadened in helium by 0.46, 0.50, and 0.47 cm^{-1}/r.d., respectively, while the same components are broadened in argon by 0.33, 0.36 and 0.30 cm^{-1}/r.d. The result for Mn/A indicates that the interatomic energies are proportional to the inverse sixth power of the interatomic distance, and that the difference in the interaction constants for the ground state ^6S and the excited states ^6P of Mn in argon is 3×10^{-58} erg cm^6.

539.18 : 537.56

13417 BROADENING OF SPECTRAL LINES IN A STRONGLY IONIZED PLASMA. M.A.Mazing and S.L.Mandel'shtam.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1329-31 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 942-3 (Oct., 1959).

Results for A II and He I lines in the spectrum of a spark discharge show that the ratio of line-width to line-shift does not have the constant value 1.6 predicted by the existing theory. The values obtained can be explained by means of the new theory of Vainshtein and Sobel'man (Abstr. 1479 of 1960). P.A.Young

539.18

13418 THE SPECTRAL DETERMINATION OF THE ISOTOPIC COMPOSITION OF STRONTIUM.
A.G.Zhiglinskii and G.G.Kund.
Optika i Spektrosk., Vol. 7, No. 6, 836-7 (Dec., 1959). In Russian.

Isotopic displacements of the spectral lines of strontium are so small that the lines of the even isotopes (Sr^{84}, Sr^{86}, Sr^{88}) merge together, while the line of Sr^{87}, whose nucleus has a spin of $I = \frac{9}{2}$, has a clear hyperfine structure. A spectroscopic technique is described for determination of the relative proportions of the even and the odd isotopes of strontium based on measuring the ratio of the intensities of a line representing the three even isotopes and of the components of a Sr^{87} line (a Sr II line at 4078 A is used). A.Tybulewicz

539.18

13419 IMPROVEMENT OF THE SENSITIVITY OF THE ISOTOPIC SPECTRAL ANALYSIS OF LEAD.
M.S.Kashtan, É.V.Sobotovich and T.N.Khlopina.
Optika i Spektrosk., Vol. 8, No. 1, 23-6 (Jan., 1960). In Russian.

Describes an improved method of spectroscopically analysing the isotopic composition of lead, using a spectrometer of the NIFI LGU type and an argon-filled discharge tube with a hollow cathode cooled with liquid air. The method is suitable also for Sn, Cd, Bi, Ag, Tl and Zn. A.Tybulewicz

539.18 : 539.14

13420 SPECTROSCOPIC DETERMINATION OF THE NUCLEAR MOMENTS OF THE ODD GADOLINIUM ISOTOPES.
N.I.Kaliteevskii, M.P.Chaika, I.Kh.Pacheva and É.E.Fradkin.
Optika i Spektrosk., Vol. 8, No. 1, 13-22 (Jan., 1960). In Russian.

A photoelectric investigation was made of the hyperfine structure of the 5015.04, 5103.45 and 5251.18 A lines of separated gadolinium isotopes and natural gadolinium. The results showed that the spin of both Gd^{155} and Gd^{157} is $I = \frac{3}{2}$ and that the quadrupole moments are either $Q_{157} = 1.6$ and $Q_{155} = 1.2 \times 10^{-24}$ cm^2, or $Q_{157} = 2$ and $Q_{155} = 1.6 \times 10^{-24}$ cm^2, depending on the assumptions made. The magnetic moments were also found: $\mu_{157} = -0.40 \pm 0.04$ n.m. and $\mu_{155} = -0.32 \pm 0.04$ n.m. Consequently the moment ratios are: $Q_{155}/Q_{157} = 0.8 \pm 0.1$, $\mu_{155}/\mu_{157} = 0.79 \pm 0.02$. The deformation parameters δ of the isotopes and their gyromagnetic ratios were also determined. A.Tybulewicz

538.18

13421 INVESTIGATION OF THE L-SPECTRA OF Zn IN THE Cu–Zn ALLOYS. I.A.Rumyantsev and M.I.Korsunskii.
Optika i Spektrosk., Vol. 7, No. 6, 850-2 (Dec., 1959). In Russian.

Reports the L-spectra of zinc in α-brass (38% Zn), $\alpha + \beta'$ (43% Zn), β' (49% Zn), $\beta' + \gamma$ (59% Zn), γ (63% Zn), $\gamma + \epsilon$ (73% Zn), ϵ (83% Zn), $\epsilon + \eta$ (92% Zn) and pure zinc; these spectra were obtained with a bent mica crystal spectrograph. A.Tybulewicz

539.18

13422 X-RAY YIELDS FROM μ-MESONIC ATOMS. M.A.Ruderman.

Phys. Rev., Vol. 118, No. 6, 1632-41 (June 15, 1960).

The interesting suggestion has been made that the rapid drop in the yield of mesonic K X-rays in the light elements may be associated with the capture of μ-mesons into the metastable 2s state. The mechanisms for making transitions from the 2s to the 1s state and from various p states into the 2s state are investigated in detail for Li, Be, and B. It is found that the paradoxical reduction of K X-rays remains unexplained. (a) Stark mixing of the mesonic 2s and 2p states by the electric fields of the atomic electrons allows "mixed" Auger-radiative transitions to the 1s state to complete favourably with radiationless transitions. These mixed transitions give a high-energy X-ray and a relatively negligible (10-50 eV) electronic excitation and so contribute to the observed Kα yield. (b) Even if the above "mixed" transitions are ignored, there is no mechanism which gets a large fraction of μ-mesons into the 2s state that at the same time does not violently contradict both theoretical estimates and observed K X-ray yields from light π-mesonic atoms.

539.18

13423 DEPOLARIZATION OF A MUON BY HYPERFINE INTERACTION. E.Lubkin.

Phys. Rev., Vol. 119, No. 2, 815-17 (July 15, 1960).

The further depolarization of a muon captured in the 1s Bohr orbit by hyperfine interaction with a nucleus of spin j is calculated. The main result is that the asymmetry parameters of the decay electrons from the J = j $\pm \frac{1}{2}$ states are multiplied by respective asymmetry reduction factors $\frac{1}{2}[1 \pm 2/(2j+1)]$.

539.18

13424 THE ENERGY LEVELS OF μ-MESIC ATOMS. N.I.Zhirnov.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 959-62 (March, 1960). In Russian.

An approximate method is proposed for calculation of μ-mesic atomic energy levels from radial Dirac equations with a potential which simultaneously accounts for nuclear volume and screening effects.

539.18 : 539.12

13425 DECAY OF μ^- MESONS BOUND IN THE K SHELL OF LIGHT NUCLEI. H.Überall.

Phys. Rev., Vol. 119, No. 1, 365-76 (July 1, 1960).

For μ^--mesons bound in the K shell of light nuclei of atomic number Z, the decay electron spectrum is calculated accurately up to the first power in Z, both for point and extended nuclei. The decay rate is evaluated accurately up to the second power for point nuclei. These results for the spectrum show the Doppler smearing of its upper end as obtained previously, and demonstrate the small effect of the nuclear extension. The decay rate is obtained as a monotonically decreasing function of Z, and recent experiments which show a maximum of the decay rate around Z ~ 26 cannot be explained. It is also found that the decay rate in second order decreases much more slowly with Z than what would be obtained from a phase space consideration alone.

MOLECULES

539.19

13426 CONFERENCE ON MOLECULAR QUANTUM MECHANICS.

Rev. mod. Phys., Vol. 32, No. 2, 169-474 (April, 1960).

The conference was held in June 1959 at the University of Colorado under the sponsorship of the National Science Foundation. There were ten sessions titled as follows: Atoms and Small Molecules I; Atoms and Small Molecules II; Atoms and Small Molecules III; The Many-Body Problem, Density Matrices; Atoms in Molecules Methods, Nature of the Chemical Bond; Reaction Rates, Intermolecular Forces; Complex Molecules; Problems in Structure and Spectra I; NMR-ESR-QR Spectroscopy; Problems in Structure and Spectra II. Abstracts of the papers presented will be found in future issues of Physics Abstracts.

539.19 : 537.56

THE IONIZATION AND DISSOCIATION OF MOLECULES BY MONO-ENERGETIC ELECTRONS. II. EXCITED STATES OF THE MOLECULAR ION OF CO_2 AND CS_2. See Abstr. 12581

539

13427 APPEARANCE POTENTIAL STUDY OF TETRAFLUOROHYDRAZINE. E.D.Loughran and C.Mader.

J. chem. Phys., Vol. 32, No. 5, 1578-9 (May, 1960).

Fragmentation mechanisms for the dissociation of N_2F_4 are proposed and bond dissociation energies evaluated.

G.I.W.Llewel

539

13428 THE APPLICATION OF PERTURBATION THEORY T THE CALCULATION OF FORCE CONSTANTS.

J.N.Murrell.

J. molecular Spectrosc., Vol. 4, No. 5, 446-56 (May, 1960).

By the application of perturbation theory the following expression is derived for the force constant of a diatomic molecule:

$$\frac{K}{2Z_aZ_b} = \frac{e^2}{r_0^3} - \sum_n e^2 \langle \rho_{0n}(i) \quad \cos\theta_{ai}/r^2{}_{ai}\rangle \times$$

$$\langle \rho_{0n}(i) \quad \cos\theta_{bi}/r^2{}_{bi}\rangle/(E_n - E_0),$$

where r_0 is the equilibrium internuclear separation, and ρ_{0n} is the transition density between the ground state and the nth excited sta By comparing the above expression with the experimental variati of K with r_0, it is shown that the sum over states is almost consta for isoelectronic molecules, and varies regularly for molecules belonging to the same group. Some of the integrals which are required for evaluating this sum are given for the first row homonuclear diatomics. It is shown how this perturbation method ma extended to polyatomic molecules.

539

13429 FORCE CONSTANTS OF SULPHUR MOLECULE. K.Venkateswarlu and P.Thirugnanasambandam.

Trans Faraday Soc., Vol. 55, Pt 12, 1993-5 (Dec., 1959).

An orthonormalized set of symmetry coordinates satisfying t transformation properties has been constructed for the rhombic sulphur molecule, S_8, belonging to symmetry D_{4d}. These symmet coordinates have been utilized in obtaining the elements of the F a G matrices which are combined with the Raman and the infrared frequencies to form the secular equations involving the force constants of the molecule. The equations have been solved and seven force constants of the S_8 molecule have been obtained.

539

13430 DIFFERENCE OF UPPER AND LOWER STATE ROTATIONAL CONSTANTS OF SYMMETRICAL TOP MOLECULES FROM INFRARED INTENSITY MEASUREMENT. T.Yoshino.

J. chem. Phys., Vol. 32, No. 5, 1574-5 (May, 1960).

The difference α of the rotational constants of the upper and lower levels of a vibrational transition is related to the normal coordinate of the vibration; the α's of a fundamental band and its harmonics are in integral ratio. Relative values of α may be obtained from infrared intensity measurements for heavy symmetrical-top molecules by the method described. R.C.Seymo

539.

13431 ENERGY LEVELS OF A SLIGHTLY ASYMMETRIC T J.A.Norris and V.W.Laurie.

J. chem. Phys., Vol. 32, No. 5, 1591 (May, 1960).

Describes an extension to a numerical table published previously by Schwendeman (Abstr. 2608 of 1958). The values of c_6 are given for J = 5(1)40, where c_6 is a coefficient in the expansion of the energy of a level in powers of the asymmetry parameter.

T.E.Peaco

539.

13432 OSCILLATOR STRENGTH OF THE NO γ-BAND SYSTEM. R.F.Hughes.

J. Opt. Soc. Amer., Vol. 50, No. 7, 740-1 (July, 1960).

Shows that the large f-value recently obtained by Erkovich (Abstr. 13163 of 1959) is due to his neglect of collisional broaden in his reduction formulae. P.A.You

539

13433 SOME THERMODYNAMIC FUNCTIONS OF GASEOUS FURAN, THIOPHENE AND PYRROL, CALCULATED FROM SPECTROSCOPIC DATA AND MOLECULAR STRUCTURE. R.Blinc and J.Pahor.

"J. Stefan" Inst. Rep., Vol. 4, 123-31 (Oct., 1957).

Heat capacities, entropies and free energies have been calcul-
d for gaseous furan, thiophene and pyrrol by means of statistical
chanics using the rigid rotator, harmonic oscillator approxi-
ion, according to the vibrational assignments of Bak, Hidalgo
Mirone. The results have been compared with published heat
acity and entropy measurements.

539.19

13434 VIBRATIONAL STATES OF THE HYDROGEN MOLECULAR ION.
ohen, J.R.Hiskes and R.J.Riddell, Jr.
rs. Rev., Vol. 119, No. 3, 1025-7 (Aug. 1, 1960).

The eigenvalues and eigenfunctions of the vibrational states
onging to the ground electronic state of the hydrogen molecular
have been calculated. The calculations have been done for the
0,2,4 and 7 rotational states. Included is a discussion of the
endence of the eigenvalues as a function of the lowest-order
amic corrections to the internuclear potential. Also, a calcula-
has been done to determine the number of bound states of the
system.

539.19

13435 A NEW PREDISSOCIATION IN NITROGEN.
A.Lofthus.
ure (London), Vol. 186, 302-3 (April 23, 1960).

The term values of the $x^1\Sigma_g^-$ and $a'\,^1\Sigma_u^-$ states of N_2 of Wilkinson
Mulliken (Abstr. 12035 of 1959) allow Lofthus' analysis of the
fifth positive system ($x^1\Sigma_g^-$, $a'\,^1\Sigma_u^-$ (Abstr. 8653 of 1956) to be re-
mined for possible predissociations which prevented bands from
> 2 being observed in spite of their prediction by the Franck—
ndon principle. The N(^{2}D) + N(^{2}D) dissociation limit lies at
, 170 cm^{-1} in the region of the J' = 13 to 15 levels of v' = 2.
pection of the (2, 3) and (2, 9) bands which were well resolved
ws a break-off of rotational structure above J' = 25 and not in
13 to 15 region. It is suggested that this predissociation is by
epulsive $^3\Sigma_g^-$ and/or a repulsive $^3\Pi_g$ state dissociating into two
nitrogen atoms. R.W.Nicholls

539.19

13436 INFRARED AND RAMAN SPECTRA OF $N_2{}^{14}O_4$ AND $N_2{}^{15}O_4$. G.M.Begun and W.H.Fletcher.
molecular Spectros., Vol. 4, No. 5, 388-97 (May, 1960).

The infrared spectra of gaseous and liquid $N_2{}^{15}O_4$ have been
served from 230 cm^{-1} to 5500 cm^{-1} and the Raman spectra of
uid and solid $N_2{}^{15}O_4$ have been recorded. The corresponding
ectra of $N_2{}^{14}O_4$ were observed to provide an accurate measure
the isotope shifts. Assignments of all eleven active fundamental
equencies have been made. These assignments fit the product
le within experimental error and account for all observed over-
nes.

539.19

13437 MICROWAVE SPECTRA AND STRUCTURE OF H_3SiCN AND D_3SiCN. N.Muller and R.C.Bracken.
chem. Phys., Vol. 32, No. 5, 1577-8 (May, 1960).

From the microwave spectra it is deduced that the C—Si bond
ngth is shorter in H_3SiCN than in H_3SiCH_3 by 0.02 A. The Si—C
nd length (1.847 ± 0.005 A) is considerably less than the sum of
e Pauling covalent radii (1.94 A). It is inferred that this is due
some double bond character involving the 3d orbitals of the
licon T.E.Peacock

539.19

13438 MICROWAVE SPECTRUM OF TRANS-CROTONONITRILE.
V.W.Laurie.
chem. Phys., Vol. 32, No. 5, 1588-9 (May, 1960).

From the spectrum, which is characteristic of a near-prolate
mmetric rotor, rotational constants and moments of inertia for
e ground vibrational state were evaluated, and a lower limit of
1 kcal/mole for the barrier to internal rotation was estimated.
E.F.W.Seymour

539.19

13439 MICROWAVE SPECTRUM OF 0^{18} FORMIC ACID AND STRUCTURE OF FORMIC ACID.
.H.Kwei and R.F.Curl, Jr.
chem. Phys., Vol. 32, No. 5, 1592-4 (May, 1960).

The microwave spectra of $HCO^{18}OH$ and $HCOO^{18}H$ are assigned
d combined with other published data to determine the structure of
rmic acid. Principal results are r(C = O) = 1.202A, r(C - O) =
1.343 A and $\angle OCO = 124^053'$. W.J.Orville-Thomas

539.19

13440 K-TYPE DOUBLING IN PHOSPHINE.
J.M.Hoffman, H.H.Nielson and K.Narahari Rao.
J. chem. Phys., Vol. 32, No. 5, 1597-8 (May, 1960).

In the microwave spectrum a doubling of the ^{R}(J,3) lines has been observed in the perpendicular band ν_4 of PH_3. It is of the order of 0.1 cm^{-1} and resembles that previously observed in NH_3. A possible theoretical explanation is given. T.E.Peacock

539.19

13441 OBSERVATION OF π STARK COMPONENTS IN MICROWAVE SPECTROSCOPY: PRECISION MEASUREMENTS ON HCN. B.N.Bhattacharya and W.Gordy.
Phys. Rev., Vol. 110, No. 1, 144-9 (July 1, 1960).

A parallel plate Stark cell was designed and constructed for the millimetre wave region of the spectrum. With the cell both π and σ Stark components can be observed. High precision Stark effect measurements were made on the π and σ components of the J = 0 → 1 transition of HCN^{14}. From these the electric dipole moment of HCN in the ground vibrational state is calculated to be 2.985 ± 0.005 Debye units.

539.19

13442 ON THE PRESSURE SHIFT OF THE INVERSION FREQUENCY OF AMMONIA. K.Tomita.
Progr. theor. Phys., Vol. 18, No. 3, 316-18 (Sept., 1957).

The shift is interpreted as due to the second order non-adiabatic effect of the electric dipole—dipole interaction between ammonia molecules. E.F.W.Seymour

539.19 : 539.14

13443 HYPERFINE STRUCTURE OF THE MICROWAVE SPECTRA OF THE NO MOLECULE AND THE NUCLEAR QUADRUPOLE MOMENT OF NITROGEN. C.C.Lin.
Phys. Rev., Vol. 119, No. 3, 1027-8 (Aug. 1, 1960).

The frequencies of the magnetic resonance spectrum of the NO molecule are recalculated using a new value of spin—orbit coupling constants and by taking the effect of l uncoupling into consideration. The agreement between the theoretical and experimental results is improved over the previous calculation. By combining the magnetic hyperfine and nuclear quadrupole coupling constants the ratio of the quadrupole moment to the magnetic moment of the nitrogen nucleus is obtained. The nuclear quadrupole moment of nitrogen is found to be (0.016 ± 0.007) × 10^{-24} cm^2. The uncertainty of this value is chiefly due to that of the coupling constants rather than to the nature of the method itself.

539.19

13444 ELECTRON CORRELATION IN THE EIGENFUNCTION OF THE GROUND STATE OF THE HYDROGEN MOLECULE. F.Berencz.
Acta. phys. Hungar., Vol. 10, No. 4, 389-405 (1959). In German.

A detailed study of electron correlation in the many quantum mechanical calculations of the dissociation energy and equilibrium distance in the H_2 molecule. R.C.Seymour

539.19

13445 GROUP ELECTRONEGATIVITIES FROM BOND LENGTHS. H.A.Bent.
J. chem. Phys., Vol. 32, No. 5, 1582-3 (May, 1960).

The composite effect of inductive influences and nominal changes in states of hybridization of carbon is discussed with reference to nine molecules containing C—F bonds. A foreshortening of the C—F bond length is taken to imply an increase in s content of the C to F orbital and also an increase in electronegativity. The sequence which arises agrees very well with that formulated by chemical evidence. T.E.Peacock

539.19

13446 VARIATIONAL PRINCIPLE FOR CALCULATION OF THE CORRECTION TO THE ELECTRON ENERGY IN A MOLECULE, QUADRATIC WITH RESPECT TO THE MAGNETIC FIELD STRENGTH. T.K.Rebane.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 963-5 (March, 1960). In Russian.

A variational principle is formulated for calculation of the diamagnetic correction to the ground-state energy of an electron in a molecule. The method is based on variation of the vector-potential gauge-transformation functions.

539.19

13447 PARAMAGNETIC ELECTRON RESONANCE OF ORGANIC RADICALS IN SOLUTION. R.Lefebvre.

Cahiers de Phys., Vol. 14, 35-40 (Jan., 1960). In French.

The observed hyperfine structure in the p.e.r. spectra of organic radicals (e.g. Ph_3C.) is attributed to electron-nuclear spin interaction. It is shown that the inclusion of excited (electronic) configurations in the ground state wave-function is necessary in order to obtain a non-vanishing spin-spin coupling constant.

T.E.Peacock

539.19

13448 C^{13} HYPERFINE SPLITTING IN BENZONITRILE NEGATIVE ION. R.L.Ward.

J. chem. Phys., Vol. 32, No. 5, 1592 (May, 1960).

Comparison of the electron spin resonances of benzonitrile ions with C^{13} in natural and enhanced abundances, respectively, in the nitrile group yielded a value for the electron spin density at the C^{13} nucleus, even though the hyperfine spectrum could not be fully analysed.

E.F.W.Seymour

539.19

13449 HYPERFINE STRUCTURE IN PARAMAGNETIC FREE RADICALS. G.Cini-Castagnoli.

Nuovo Cimento, Vol. 15, No. 2, 201-8 (Jan. 16, 1960).

Paramagnetic resonance of solutions in dioxane of the free radical $[(C_7H_7)_3N]^+ ClO_4^-$ has been investigated. Hyperfine structure has been found which can be interpreted in terms of the interaction of the unpaired electron with the nitrogen nucleus and with some of the hydrogens on the phenyl rings.

539.19

13450 LCAO-MO-SCF GROUND STATE CALCULATIONS ON C_2H_2 AND CO_2. A.D.McLean.

J. chem. Phys., Vol. 32, No. 5, 1595-7 (May, 1960).

A basis of Slater orbitals with modified exponents is used to discuss the ground state energies of C_2H_2 and CO_2, which are discussed as 14 and eighteen electron problems respectively. The calculations lead to the following: Total electronic energy, C_2H_2 −101.28327 a.u., CO_2 −245.17305 a.u.; Total energy C_2H_2 −76.54383 a.u., CO_2 −186.84275 a.u.

T.E.Peacock

539.19

13451 MOLECULAR ORBITAL TREATMENT OF $1s\sigma\, 2p\sigma\ {}^3\Sigma_u$ STATE OF H_2. S.Huzinaga.

Progr. theor. Phys., Vol. 19, No. 1, 125-6 (Jan., 1958).

This repulsive state is considered in a single configuration MO approximation, using two alternative forms for the MO's. The first is of LCAO type using different exponents in the two MO's, and the second is of James type. The repusive energy results are given for three internuclear distances, and are encouragingly close, for both forms, to the James—Coolidge—Present results (1936).

J.Hawgood

539.19

13452 ON THE ORBITAL APPROACH TO THE MANY-ELECTRON PROBLEM IN MOLECULE. S.Huzinaga.

Progr. theor. Phys., Vol. 20, No. 1, 15-34 (July, 1958).

The lowest ${}^3\Sigma_u{}^+$ and ${}^1\Sigma_u{}^+$ states of the hydrogen molecule, the interaction energy between two normal helium atoms and the ${}^3B_{1u}$ and ${}^1B_{1u}$ states of the ethylene molecule are treated by the method of the molecular orbitals in the single configuration approximation. The results are encouraging and the reason for this success is that molecular orbitals were used which are a little more flexible than the conventional LCAO MO's. It is confirmed that the failure of the conventional ASMO LCAO approximation does not necessarily imply the breakdown of the useful concept of "molecular orbutal" itself.

539.19

13453 CALCULATED BOND LENGTHS, BOND ORDERS AND π-ELECTRON DISTRIBUTION IN NAPHTAZARINE.

R.Blinc and E.Pirkmajer.

"J. Stefan" Inst. Rep., Vol. 4, 133-7 (Oct., 1957).

Energy levels, bond orders and bond lengths have been deduced for 5,8-dihydroxy — 1,4 naphtoquinone by the LCAO molecular-orbital method with neglect of overlap. The calculated electronic energy levels are in a good agreement with those measured from the near ultraviolet spectrum.

53

13454 SOME OBSERVATIONS ON ATOMIC EXCHANGE IN W.Spindel and M.J.Stern.

J. chem. Phys., Vol. 32, No. 5, 1579-81 (May, 1960).

Mass-spectrometric studies were made on $N^{14}O^{16}/N^{15}O^{16}$ an $N^{14}O^{16}/N^{14}O^{18}$ samples (purified to minimize the concentration of higher oxides of nitrogen) to determine the rate of equilibrati and whether exchange in such samples could proceed through the formation of a dimer intermediate, $(NO)_2$, of a square structure, well as by the known higher oxide mechanism. Samples were mi at a total pressure of ~ 2 cm Hg. Complete exchange occurred less than the time (15-30 sec) required for measurement. Exper ments with mixtures of the oxides at low press. (rate of equilibr ~ 1000 times slower) and low temp. (oxides frozen) indicate that dimer formed in solid nitric oxide does not have a square structu containing N—O bridges.

W.(

53

13455 SPECTRAL AND REACTIVITY DIFFERENCES OF TRANSITION METAL IONS IN H_2O AND D_2O.

J.Bigeleisen.

J. chem. Phys., Vol. 32, No. 5, 1583-4 (May, 1960).

Some effects such as difference in dipole moments, strength hydrogen bonds, etc. which contribute to spectral shifts and to t difference in chemical properties of transition metal ions in H_2O D_2O solvents are discussed.

W.J.Orville-Thom

539

13456 CHARGE-TRANSFER FORCES IN MOLECULAR COMPOUNDS. S.Aono.

Progr. theor. Phys., Vol. 20, No. 2, 133-43 (Aug., 1958).

Charge-transfer energies or electron exchange energies are calculated between conjugated chain molecules and between benze molecules which are formed into molecular compounds from the same species and called self-complexes. The essential nature o these energies is that these are largest in the displaced position when one molecule is laterally translated by some bond lengths t the other, and values of which cannot be negligible relative to the dispersion energies at the normal separation distance at which t molecular compounds are formed. The results obtained explain observed phenomena qualitatively.

539

13457 SHORT AND LONG-RANGE INTERACTIONS IN THE LINEAR MACROMOLECULE. A.Peterlin.

"J. Stefan" Inst. Rep., Vol. 5, 61-9 (Oct., 1958).

The shape of the linear macromolecule in solution depends o the valency angle, steric and energetic hindrance of rotation aro the chemical bond (short range interactions), on the volume effec and the interactions with the solvent (long range interactions). T short range interactions determine the length of the statistical segment, i.e. the number of monomers one has to proceed along the chain until the orientation of the chain tangent becomes indep dent from the orientation of the starting element. The long range interactions, however, as a rule do not change the character of t statistical segment, but due to the volume requirement of the cha favour the more extended configurations. As a consequence the mean end-to-end distance of the coil increases more rapidly as the square root of the number of chain elements. The effect is greatest in good solvents and disappears in precipitant solutions. The length of the statistical segment can be estimated from smal angle X-ray scattering and from the optical anisotropy of the segment as determined by streaming birefringence. The non-Gaussian character due to the long range interaction can be meas ured by the more than linear increase of R^2 with polymerization degree as determined from light scattering, intrinsic viscosity and sedimentation.

53

13458 μ-MESONIC MOLECULES. I. THREE-BODY PROBLEM. S.Cohen, D.L.Judd and J.Riddell, Jr.

Phys. Rev., Vol. 119, No. 1, 384-97 (July 1, 1960).

An approximate method is developed for treating a generali hydrogen-molecule ion in which two heavy particles have positiv unit charges and one light particle has a negative unit charge. T expansion parameter of this approximation is the ratio of the lig to the heavy mass. In first order, the method requires finding a solution to a pair of ordinary, second-order differential equation which are coupled unless the masses of the heavy particles are equal. Explicit expressions for the coefficients in these equatio derived. The asymptotic forms of these coefficients for large lear separations give to first order the reduced mass corrections he binding energy of the light particle on either of the two heavy ticles. The usual scattering theory is extended to obtain formulae the various possible cross-sections associated with this system. iterative, variational technique for obtaining eigenvalues and enfunctions for bound states of the system is presented.

539.19

13459 μ-MESONIC MOLECULES. II. MOLECULAR-ION FORMATION AND NUCLEAR CATALYSIS.
ohen, D.L.Judd and R.J.Riddell, Jr.
ys. Rev., Vol. 119, No. 1, 397-411 (July 1, 1960).

The methods developed in Pt I are applied to the study of the aviour of μ-mesons in liquid hydrogen. Numerically evaluated rgy eigenvalues for the bound states of the various molecular-ion figurations are presented. Phase shifts and cross-sections for the ttering of mesonic atoms from hydrogen and deuterium are given. s shown that in the neighbourhood of 0.2 eV the scattering of (dμ) ms from protons exhibits a Ramsauer—Townsend effect with an malously small cross-section occurring in this region. The stence of this effect provides an explanation for the appearance of ps" in the experimental observation of the catalytic process. The e of exchange of mesons from protons to deuterons in pure deuterium is calculated along with the rates of formation of the $(p\mu p)^+$, $(p\mu d)^+$, and $(d\mu d)^+$ molecular ions. It is shown that the predominant mechanism for the formation of the molecular ions is dipole electron ejection. These results are shown to be in agreement with available experimental data. A semiphenomenological treatment of the (p, d) nuclear reaction is also given. A rough estimate of the γ-emission process indicates that the dominant mode of emission is from the singlet proton spin states.

539.19

13460 FORMATION OF μ-MESONIC MOLECULES IN H—D MIXTURES.
J.G.Fetkovich, T.H.Fields, G.B.Yodh and M.Derrick.
Phys. Rev. Letters, Vol. 4, No. 11, 570-2 (June 1, 1960).

Negative muons were stopped in a bubble chamber containing 94.9 atomic % deuterium and 5.1 atomic % hydrogen. In pictures containing 2201 ± 50 μ—e decays there were 96 ± 16 cases of $d + d = H^3 + p$ and 33.8 ± 5.6 regenerations. Allowing a 1 : 1 branching ratio between $H^3 + p$ and $He^3 + n$ it is deduced that the molecule formation time $\lambda_{DH} > 1 \times 10^7$ sec^{-1}. Using also previous experimental data gives $\lambda_{DD} > 1.7 \times 10^5$ sec^{-1}. These values are several times higher than theoretical ones obtained by Cohen, Judd and Riddell (see preceding abstract). A.Ashmore

SOLID-STATE PHYSICS

539.2

13461 AN EQUATION OF STATE FOR METALS OBTAINED BY A STATISTICAL METHOD. V.P.Trubitsyn.
z. tverdogo Tela, Vol. 2, No. 5, 898-902 (May, 1960). In Russian.

Gives a statistical derivation of an approximate equation of ate for metals at pressures from zero to 10^6 atm and T = 0°K. e electron density in the ionic skeleton, found using the Hartree—ck method and approximated by an exponential function, is bstituted into the statistical expression for energy. An explicit pression is obtained for the dependence of energy and pressure on lume. The method is illustrated for magnesium. A.Tybulewicz

539.2

13462 PHENOMENOLOGICAL GENERALIZATION OF THE THOMAS—FERMI—DIRAC (TFD) EQUATION IN THE ASE OF THE THEORY OF METALS AND ITS PERIODIC LUTIONS. D.F.Kurdgelaidze.
ta phys. Hungar., Vol. 9, No. 1-2, 185-94 (1958). In Russian.

The exchange interaction between metal atoms is taken into count phenomenologically by writing the TFD equation in the form:

$$\Delta\varphi = \bar{a}(\varphi^{1/2} + \bar{\tau}_0)^3 + \lambda_3.$$

ere $\bar{a}\rho\bar{\tau}_0$ and λ_3 are treated as free parameters to be adjusted to e following properties of the metal: lattice constant, work function minimal Fermi potential and average or boundary density of the nducting electrons. The equation has periodic solutions and the operties of the latter are discussed. As an example, the case of dium is investigated in detail.

539.2

13463 EXTENSION OF HUYGENS' PRINCIPLE TO A DISCONTINUOUS MEDIUM: A SOLID CONSIDERED AS AGGREGATE OF ATOMS. P.Boillet.
R. Acad. Sci. (Paris), Vol. 250, No. 20, 3274-6 (May 16, 1960). French.

It is shown that, in a solid composed of atoms having a radius of tion limited to R, vibrations propagated outside a closed surface ntaining a source of vibrations are the same as those that would obtained by replacing this source by suitable sources situated at ferent parts of that surface and at a distance from it of less n R. H.J.H.Starks

539.2

13464 ON THE ORIGIN OF THE INTERNAL PRESSURE IN METALS. G.Borelius.
rk. Fys., Vol. 16, Paper 37, 413-16 (1960).

The author has previously introduced the relation $(\alpha + \Delta p) \times$ $+ \Delta V) = \alpha\beta$ between the charge ΔV of the atomic volume V and e charge Δp of the external pressure. It is now suggested that the pressure parameter α should equal $\frac{2}{3}E/V$ where E is the zero-point kinetic energy of the valence electrons. Results of compressibility and electronic specific heat measurements are interpreted to support the suggestion. D.M.Edwards

539.2

13465 SOME PROBLEMS OF GROWTH, STRUCTURE AND PROPERTIES OF SEMICONDUCTOR MONOCRYSTALS.
D.A.Petrov.
Acta phys. Hungar., Vol. 9, No. 1-2, 217-27 (1958). In Russian.

Thermal stability of AlSb, GaSb, InSb and Ge was investigated by viscosity measurements in their molten phase. The corresponding free-energy curves possess a minimum, possibly indicating a change in the coordination number. Conditions of monocrystalline growth are given and a modified version of the Czochralski method is described. The connection between some structure-sensitive properties of these crystals and their homogeneity is discussed.

539.2

13466 MELTING AND CRYSTAL STRUCTURE. TESTS OF THE ASSOCIATION COMPLEX THEORY FOR SOME LOW-MELTING SALTS. J.P.Frame, E.Rhodes and A.R.Ubbelohde.
Trans Faraday Soc., Vol. 55, Pt 12, 2039-47 (Dec., 1959).

Measurements have been made of electric conductance of solid and molten sodium and potassium nitrites and potassium dichromate, and on molten thallium nitrate. Viscosities of melts of these salts have also been determined. Like other low-melting salts previously studied, these melts have low ratios of the activation energies $E\eta/E\sigma$ for viscosity and ion conductance, pointing to the presence of association complexes. Entropies of activation for viscous flow have also been evaluated on the basis of absolute-reaction-rate equations. Though high negative entropies indicating highly selective relaxation mechanisms are found for some of the nitrates, no general correlation between selective processes and low melting points can be postulated. From the ratio of electrical conductances $\sigma_{liquid}/\sigma_{solid}$ for these salts, premelting in the crystals appears to be much less prominent than in the silver halides, except for KNO_2. However, the low activation energies for conductance in some of these salts suggests some electronic conductance in the solids, which may obscure homophase premelting. Conductivity data reveal a hitherto unknown transformation in solid KNO_2. This appears to be continuous, with onset temperature of about 365°C. Measurements of surface energies have been made on $NaNO_2$, KCNS, $K_2Cr_2O_7$ and $KClO_3$, near the freezing points of their melts.

539.2

13467 AN APPROXIMATE CALCULATION OF THE SURFACE ENERGY OF SOME SEMICONDUCTORS WITH THE DIAMOND AND ZINC BLENDE STRUCTURE. S.N.Zadumkin.
Fiz. tverdogo Tela, Vol. 2, No. 5, 878-82 (May, 1960). In Russian.

Nearest-neighbour interaction is used to derive a simple formula for the free surface energy and its temperature dependence for faces of an ideal single crystal with considerable covalent bonding. Using the Debye expression for the vibrational contribution, the high ($T \gg \Theta$) and low ($T \ll \Theta$) temperature expressions are given. A table shows $\sigma_{(100)}$ at absolute zero and at 298°K and $\partial\sigma_{(100)}/\partial T$ at 298°K for diamond, Si, Ge and $\sigma^0_{(100)}$ for GaAs, GaSb, InAs, InSb and CSi. Results for $\sigma_{(100)}$ and for the ratios of σ for different faces are in good agreement with experimental data. R.Berman

539.2

13468 PREPARATION AND PROPERTIES OF SAMARIUM HEXABORIDE.

G.V.Samsonov, N.N.Zhuravlev, Yu.B.Paderno and V.R.Melik-Adamyan.

Kristallografiya, Vol. 4, No. 4, 538-41 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 4, 507-9 (April, 1960).

The work function was found to be 4.4 eV, and the emission coefficient varied linearly from 0.75 at 900°C to 0.68 at 1600°C. The thermo-e.m.f. coefficient was 3.4 μV/°C over the range 20° to 60°C. The melting point was 2540°C (in argon) and the density calculated to be 4.85 g/cm³, sintered specimens attaining 4.79 g/cm³. The thermal expansion coefficient was 6.5×10^{-6} from 20° to 800°C.

539.2

13469 CONTRIBUTION TO THE STUDY OF ZINC, GALLIUM, GERMANIUM AND ALLOYS OF COPPER BY X-RAY SPECTROGRAPHY.

A.Lucasson.

Ann. Phys. (Paris), Ser. 3, Vol. 5, No. 5-6, 509-65 (May-June, 1960). In French.

The first part deals with L emission and absorption spectra of Zn, Ga, Ge in the solid state. The second part is concerned with changes in the Lα band and the L_{III} absorption edge of copper associated with different copper alloys, e.g. copper—nickel, copper—zinc. The L_{III}, L_{II} and L_I absorption edges of gallium and germanium have been determined for the first time as well as the zinc L_{II} edge. Previously determined spectra have been re-measured. The crystalline state of the absorbing films was checked by electron diffraction and was correlated with the observed X-ray spectra. In addition the X-ray results have been compared with results of optical measurements. The agreement is satisfactory.

T.Mulvey

539.2

13470 ISOLATED FRINGES CLOSE TO THE X-RAY K DISCONTINUITY OF COPPER.

C.Kurylenko.

Cahiers de Phys., Vol. 113, 25-8 (Jan., 1960). In French.

The widths and dissymmetries of these fringes are discussed.

A.R.Stokes

539.2

13471 THE K-ABSORPTION SPECTRUM OF NEUTRON IRRADIATED NICKEL.

D.Bally and L.Benes.

Nuovo Cimento, Vol. 14, No. 6, 1384-6 (Dec. 16, 1959).

Ni and a Ni—Cu alloy was irradiated at neutron fluxes up to 10^{18}/cm² at temperatures below 80°C. In some experiments the specimens were shielded from thermal neutrons by Cd. It was found that the K-absorption edge of Ni, in both the alloy and the element, showed a neutron-induced "structure". Changes in the K_1 discontinuity began at an integrated flux of about 10^8 n/cm², and in the K_2 at lower values. The observed modifications were caused primarily by neutrons with energy above 0.7 eV.

J.Thewlis

539.2

13472 THE VAPOUR PRESSURE OF SOLID CADMIUM.

A.T.Aldred, J.D.Filby and J N.Pratt.

Trans Faraday Soc., Vol. 55, Pt 12, 2030-5 (Dec., 1959).

The vapour pressure of solid cadmium in the temperature range 200-290°C has been re-measured using a torsion-effusion technique. The values obtained may be expressed as the equation: $\log_{10}\rho(\text{mm Hg}) = 9.404 - 6146/T$. The standard heat of sublimation, ΔH^0_{298} is estimated as 26.90 ± 0.1 kcal mole. The results are compared with those of other workers and with those computed from measurements on the liquid.

539.2 : 536.4

13473 MEASUREMENT OF THE VAPOUR PRESSURE OF SOLID CHROMIUM BY A RADIOACTIVE TRACER METHOD.

A.N.Nesmeyanov and De Dyk Man.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 6, 1383-5 (April 21, 1960). In Russian.

Measured by an integral variant of Knudsen's effusion metho using as the tracer Cr^{51} produced in the specimen by neutron irra diation. The values are plotted as a function of temperature and compared with earlier results. The heat of sublimation of Cr is derived. See Abstr. 5626 of 1959. R.F.S.Hearm

53

13474 MADELUNG CONSTANTS OF THE CUBIC PEROVSKI STRUCTURES.

F.G.Fumi and M.P.Tosi.

J. chem. Phys., Vol. 33, No. 1, 1-2 (July, 1960).

A proof is given of a simple linear relation between the Madelung constant, referred to the lattice parameter a, of a cubic perovskite structure ABX_3 with the ionic charges in the ratio $+z : +(3-z) : -1$ and the corresponding Madelung constants for t NaCl, CsCl, and Cu_2O structures.

53

13475 MADELUNG CONSTANT FOR K_2SO_4(II).

R.H.Wood.

J. chem. Phys., Vol. 32, No. 6, 1690-2 (June, 1960).

The Madelung constants of NaCl, CsCl, and K_2SO have been calculated with the aid of a digital computer. The method of sum ming over neutral shells of atoms with each shell being compose unit cells is used. This method allow the presence of surface dipole moments (de Boer effect) to be ignored. The results for K_2S allow the calculation of the Madelung constant as a function of the charge on the oxygen ($M_\delta = 6.922 + 0.36\epsilon$).

53

13476 THEORY OF COHESIVE ENERGY OF LiH CRYSTAL. THE METHOD OF SEMI-LOCALIZED CRYSTALLINE ORBITAL (SLCO). I.

A.Morita and K.Takahashi.

Progr. theor. Phys., Vol. 19, No. 3, 257-68 (March, 1958).

The influence of homopolar binding on the cohesive energies of i crystals is studied by the SLCO method; computations are perform for the LiH crystal. As a result, it is shown that the discrepancy between the theoretical value of the cohesive energy of LiH, calculated by Lundqvist (Abstr. 1072 of 1955) and the observed one is removed by taking homopolar binding into account. Furthermore, the relation between the energy band structure and SLCO is discu and it is shown that SLCO corresponds to Wannier's functions of the valence and conduction bands for the case of LiH crystal wher the valence and conduction bands are non-degenerate.

53

13477 THEORY OF COHESIVE ENERGIES AND ENERGY-BAND STRUCTURES OF DIAMOND-TYPE VALENCE CRYSTALS. THE METHOD OF SLCO. II.

A.Morita.

Progr. theor. Phys., Vol. 19, No. 5, 534-40 (May, 1958).

See preceding abstract. The SLCO method is used to develo the theory of the cohesive energies of diamond-type valence cryst A formula determining ionicity of diatomic crystals such as InSb presented. A new method of calculating the energy-band structu of these crystals is described.

539.2 :

13478 AN ANALYTICAL APPROACH TO THE DIFFUSION BONDING PROBLEM.

L.S.Castleman.

Nuclear Sci. Engng, Vol. 4, No. 2, 209-26 (Aug., 1958).

Attention is focused on the interdiffusional aspects of the diff sional bonding problem as it relates to the fabrication of clad fuel elements and their operation at elevated temperatures. Certain idealized cases of core-cladding interdiffusion occurring in singl phase, two-phase, and three-phase systems are examined analytically. In the two-phase and three-phase systems, the importance of the roles played by the boundary and interface concentrations a the diffusion coefficients in controlling interface movement and interdiffusion is evaluated in detail.

539.2 : 53

THERMODYNAMIC PROPERTIES OF ISOTOPES Ne^{20} AND N IN SOLID STATE. See Abstr. 12416

539.2 : 539

PERIODIC GROUND STATES AND THE MANY-BODY PROBLEM. See Abstr. 12885

539.2 : 539

VARIATION WITH TEMPERATURE OF THE ENERGY OF RECOIL-FREE GAMMA RAYS FROM SOLIDS. See Abstr. 11313

539.2 : 539.

TEMPERATURE-DEPENDENT SHIFT OF γ RAYS EMITTED BY A SOLID. See Abstr. 11314

ice Dynamics

539.2

3479 **LATTICE DYNAMICS OF ALKALI HALIDE CRYSTALS.**
A.D.B.Woods, W.Cochran and B.N.Brockhouse.
s. Rev., Vol. 119, No. 2, 980-99 (Aug. 1, 1960).
Theoretical and experimental studies are described. A theory
he lattice dynamics of ionic crystals is given based on replace-
nt of a polarizable ion by a model in which a rigid shell of elec-
ns (taken to have zero mass) can move with respect to the mas-
e ionic core. The dipolar approximation then makes the model
ctly equivalent to a Born—von Karman crystal in which there are
oms" of differing charge at each lattice point, one of the "atoms"
ing zero mass. The model has been specialized to the case of an
li halide in which only one atom is polarizable, and computations
ispersion curves have been carried out for sodium iodide. The
hors have determined the dispersion $\nu(q)$ relation of the lattice
rations in the symmetric [001], [110], and [111] directions of
ium iodide at 110° K by the methods of neutron spectrometry.
transverse acoustic, longitudinal acoustic, and transverse optic
nches were determined completely with a probable error of about
The dispersion relation for the longitudinal optic (LO) branch
determined for the [001] directions with less accuracy. Fre-
ncies of some important phonons with their errors (units 10^{12} c/s)
: TA[0,0,1] 1.22 ± 0.04, LA[0,0,1] 1.82 ± 0.06, TA$[\frac{1}{2},\frac{1}{2},\frac{1}{2}]$
± 0.05, LA$[\frac{1}{2},\frac{1}{2},\frac{1}{2}]$ 2.32 ± 0.06, TO[0,0,0] 3.6_0 ± 0.1, TO[0,0,1]
± 0.1, TO$[\frac{1}{2},\frac{1}{2},\frac{1}{2}]$ 3.5_0 ± 0.1. The agreement between the experi-
ntal results and the calculations based on the shell model, while
complete is quite satisfactory. The neutron groups correspon-
to phonons of the LO branch were anomalously energy-
adened, especially for phonons of long wavelength, suggesting a
narkably short lifetime for the phonons of this branch.

539.2

13480 **LATTICE VIBRATIONS IN ALKALI HALIDE CRYSTALS. II. POTASSIUM AND RUBIDIUM HALIDES; CESIUM**
UORIDE. A.M.Karo.
nem. Phys., Vol. 33, No. 1, 7-20 (July, 1960).
For Pt I, see Abstr. 2782 of 1960. Vibrational frequency dis-
butions have been evaluated on the basis of the Born lattice theory.
the use of Blackman's numerical sampling method. Both room-
nperature and extrapolated 0° K parameters have been used in
calculation. Specific heats, the corresponding Debye characte-
tic temperatures, and the moments of the distributions have been
ained directly from the frequencies. Comparison is made with
erimental data and with other theoretical work.

539.2

13481 **REMARKS ON THE VIBRATIONAL PROPERTIES OF ONE-DIMENSIONAL IONIC LATTICES.** G.Weiss.
l. Res. Coun. Israel, Vol. 7F, No. 4, 165-70 (Dec., 1958).
Two models are analysed for a one-dimensional ionic lattice;
with a long-range interaction of the form $\exp(-\lambda r_{jk})$ and the
er of the form $1/r_{jk}$, where r_{jk} is the distance between the
and k'th atoms. A dispersion relation and frequency spectrum
be found for these models in closed form. One finds, as in the
e of the previously investigated Coulomb force model, that no
re than two singularities appear in the spectrum. For the two
dels, the nature of the singularities can easily be investigated
ause of the simple form of the dispersion relation.

539.2

3482 **EXPERIMENTAL STUDIES OF ATOMIC VIBRATIONS IN CRYSTALS AND OF THEIR RELATIONSHIP TO**
ERMAL EXPANSION. K.Lonsdale.
Krist., Vol. 112 [Max Laue Festschrift], 188-212 (1959).
The factors bearing on the relationship between thermal expan-
n and atomic vibrations are pointed out and discussed. Published
ues of thermal expansion coefficients for a number of materials
onging to various crystal systems are tabulated and the relation-
p of crystal dynamics and expansion to melting point is considered.
R.F.S.Hearmon

539.2

13483 **THE REPULSION ENERGIES IN IONIC COMPOUNDS. II. LATTICE ENERGIES OF SOME METALLIC NITRIDES.**
.Baughan.
ns Faraday Soc., Vol. 55, Pt 12, 2025-9 (Dec., 1959).
For Pt I, see Trans Faraday Soc., Vol. 55, Pt 5, 736-52 (May,
9). The lattice energies of some face-centred cubic nitrides MN are calculated, supposing them to be ionic crystals $M^{3+}N^{3-}$. The lattice energies are given to about 1%, which may well be the uncertainty of the X-ray data, and the form of the repulsion energy agrees with compressibility data for TiN and with the theory of Pt I. The value −511 ± 57 kcal/mole is recommended for the three-stage electron affinity $N \rightarrow N^{3-}$; this value is roughly supported by extrapolating ionization potentials.

539.2

13484 **FREQUENCY SPECTRUM FOR A TWO-DIMENSIONAL LATTICE.** J.Neuberger and R.D.Hatcher.
J. chem. Phys., Vol. 33, No. 1, 265-9 (July, 1960).

The methods of lattice dynamics are applied to a study of the frequency distribution function $f(\nu)$ of a two-dimensional model of a monatomic crystal. It is shown that if the interaction of the atoms of the lattice is of short range such that next-nearest neighbour interactions are much weaker than nearest neighbour interactions, the function $f(\nu)$ can be expressed in terms of elliptic integrals of the first kind. These functions are calculated for a particular choice of the ratio of the interaction constants which had previously been discussed in the literature by approximate numerical methods This gives some evidence that the numerical scheme for obtaining $f(\nu)$, based on a comparatively small spanning of wave-vector space which is used extensively in more complicated crystal models, is adequate provided that ν is a fairly smooth function of the wave vector.

539.2

13485 **DISPERSION RELATIONS AND VIBRATIONAL FREQUENCY SPECTRA.** A.A.Maradudin and G.H.Weiss.
Nuovo Cimento, Vol. 15, No. 3, 408-15 (Feb. 1, 1960).

Many relations have been given connecting the dispersion relations and frequency spectrum for a vibrating lattice. It is the purpose of this paper to show that these relations can all be derived from a single integral representation by using different representations of the δ-function.

539.2

13486 **VIBRATIONAL MODES NEAR IMPURITIES.** H.B.Rosenstock and C.C.Klick.
Phys. Rev., Vol. 119, No. 4, 1198-1203 (Aug. 15, 1960).

In many cases, the interaction between the electronic state of an impurity in a solid and the motion of the atoms in the lattice is controlled by the relative motion of the impurity with respect to its nearest neighbours. The nature of the vibrations of the lattice near an impurity, is therefore considered. In particular, two problems are considered: (a) the direct absorption of light by the "localized" mode introduced by the presence of the impurity, and the relation of its frequency to that of the "reststrahlen" absorption; (b) the relative importance of the "localized" modes and of the "lattice" modes in producing the observed broadening of the spectra due to electronic transitions of the impurity centre. It is found that the large number of lattice modes together produce a mean displacement of the same order of magnitude as do the very few local ones. The implications for the "configuration coordinate" model for phosphors are examined; both theory and experiment suggest that if only one mode, or group of modes, are effective in producing broadening, their frequency is substantially lower than that of the localized modes which are optically active.

539.2

13487 **THERMAL AGITATION OF ATOMS IN A CRYSTALLINE MEDIUM. II.** J.Laval.
J. Phys. Radium, Vol. 20, No. 4, 449-55 (April, 1959). In French.

For Pt I, see Abstr. 4006 of 1959. The frequency of a fundamental oscillation varies with the amplitude of the thermal agitation. Secondary oscillations have the frequencies $|\nu_1 \pm \nu_2|$; $|\nu_1 \pm \nu_2 \pm \nu_3|$ ... ; ν_1, ν_2, ν_3, ..., being the frequencies of fundamental oscillations. They take amplitudes proportional to the products of the amplitudes of the fundamental oscillations.

539.2

13488 **STUDIES OF THE ANISOTROPIC THERMAL VIBRATIONS OF THE ATOMS IN SEVERAL HEXAGONAL CARBIDES AND DIBORIDES OF TRANSITION GROUP METALS.**
A.M.Belikov and Ya.S.Umanskii.
Kristallografiya, Vol. 4, No. 5, 684-6 (Sept. - Oct., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 643-5 (May, 1960).

The carbides Nb_2C, W_2C, Mo_2C, and WC were examined, and the

diborides ZrB_2 and TiB_2. For the ideal structure of MeC, where the Me atoms are in a simple hexagonal lattice, the ratio c/a should equal unity, but in fact is slightly less. For the ideal structure of Me_2C, where the Me atoms are in a close-packed hexagonal lattice, the c/a ratio is 1.633, but in practice is again slightly reduced. Hence, there are two types of Me-Me distance, resulting in different amplitudes of thermal vibration and different coefficients of thermal expansion in the basal plane and in the direction perpendicular to it. The coefficients of thermal expansion in the basal plane and in a direction perpendicular to it were measured as a function of $m\theta^2$, where m is the mass of the atom, and θ the characteristic temperature of the thermal vibration. In addition the bond strengths of the metal atoms in the carbides and diborides were also measured. The bonds present in the various compounds are discussed in terms of the measured anisotropy of $(m\theta^2)_a$ and $(m\theta^2)_c$, and of α_a and α_c.
R.V.Coates

539.2

13489

SPECIFIC HEAT OF INDIUM BELOW 1°K.

C.A.Bryant and P.H.Keesom.

Phys. Rev. Letters, Vol. 4, No. 9, 460-2 (May 1, 1960).

The authors' experimental values are analysed and held to show that the lattice contribution is smaller in the superconducting than in the normal state.
J.W.Leech

539.2

13490

THE SPECIFIC HEATS OF THE TRISULPHIDES OF ARSENIC, ANTIMONY AND BISMUTH IN RELATION TO THEIR STRUCTURAL AND PHYSICO-CHEMICAL PROPERTIES.

V.A.Romanovskii and V.V.Tarasov.

Fiz. tverdogo Tela, Vol. 2, No. 6, 1287-93 (June, 1960). In Russian.

The authors review the structures of the sulphides and compare the experimental specific heats with those calculated for chain structures [Tarasov, Dokl. Akad. Nauk SSSR, Vol. 46, 117 (1945)]. The force constants are calculated from the Debye temperatures and are compared with those for a diatomic molecule composed of the two atoms considered. The ratio is constant at approximately 4.5. Graphs are plotted of the energy gap against the force constant. These are approximately straight lines for both the above series of sulphides and the Group IV semiconductors.
M.E.Priestley

539.2 : 536.7

13491

THE LOW TEMPERATURE SPECIFIC HEAT AND THE ENTROPY AT 298.1°K OF THE SULPHIDES OF THE FIFTH GROUP OF MENDELEEV'S PERIODIC TABLE.

V.A.Romanovskii and V.V.Tarasov.

Fiz. tverdogo Tela, Vol. 2, No. 6, 1294-9 (June, 1960). In Russian.

Measurements were made over the range 65-300°K using an electrically heated adiabatic calorimeter. Detailed results are given for As_2S_3, Sb_2S_3 and Bi_2S_3. The entropies were determined by extrapolation of the specific heats to 0°K.
M.G.Priestley

539.2

13492

AN X-RAY METHOD OF DETERMING THE TENSOR OF THERMAL EXPANSION IN LOW-SYMMETRY CRYSTALS.

Z.I.Ezhkova, G.S.Zhdanov and M.M.Umanskii.

Kristallografiya, Vol. 4, No. 5, 723-6 (Sept.-Oct., 1959). In Russian. English translation in Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 683-7 (May, 1960).

A method is suggested for determining the positions of the principal axes of the tensor of thermal expansion with respect to the positions of the crystallographic axes of a triclinic crystal and thereby determining the magnitude of the corresponding coefficients of thermal expansion.

539.2

13493

THERMAL EXPANSION COEFFICIENTS OF BISMUTH.

E.F.Cave and L.V.Holroyd.

J. appl. Phys., Vol. 31, No. 8, 1357-8 (Aug., 1960).

The linear thermal expansion coefficients of the a and c axes of bismuth have been measured from 80°K to 540°K by mechanical means. These same coefficients were determined over a more limited range of temperatures by single crystal and powder X-ray methods. The mechanical and X-ray values did not differ significantly. The expansion coefficient for the c axis was found to be $16.6 \pm 0.4 \times 10^{-6}\,\mathrm{deg}^{-1}\,\mathrm{C}$ at 100°K, $17.3 \pm 0.2 \times 10^{-6}\,\mathrm{deg}^{-1}\,\mathrm{C}$ at 150°K, and $17.6 \pm 0.2 \times 10^{-6}\,\mathrm{deg}^{-1}\,\mathrm{C}$ at 540°K. For the a axis the expansion coefficient was $10.8 \pm 0.3 \times 10^{-6}\,\mathrm{deg}^{-1}\,\mathrm{C}$ at 100°K, $11.6 \pm 0.2 \times 10^{-6}\,\mathrm{deg}^{-1}\,\mathrm{C}$ at 150°K, and $11.8 \pm 0.2 \times 10^{-6}\,\mathrm{deg}^{-1}\,\mathrm{C}$ at 540°K.

539.2 : 536.

13494

THERMAL EXPANSION OF SILICON AT LOW TEMPERATURES.

S.I.Novikova and P.G.Strelkov.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1841-3 (Dec., 1959). In Russi

Linear thermal expansion of silicon monocrystals of semiconductor purity was studied between 22 and 340°K. Below 120°K the expansion coefficient was negative with a vague minimum at 80-90°K; near 0°K the coefficient tended to zero. The results agreed fairly well with those of Erfling (Abstr. 384 of 1943) and Gibbons (Abstr. 3385 of 1959).
A.Tybulew

539

13495

INFLUENCE OF PRESSURE ON SOME PROPERTIES SOLID BODIES.

Yu.N.Ryabinin.

Zh. tekh. Fiz., Vol. 30, No. 6, 739-41 (June, 1960). In Russian.

On the basis of the Debye—Grüneisen theory, equations are derived for the variation in volume, characteristic temperature, thermal expansion and melting point of solids with pressure. Cal culated melting points of Pb, Al, Cu and Fe agree with experimen values.
R.F.S.Hearm

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13496

ON ANOMALIES IN THE PROPERTIES OF ZINC.

A.A.Presnyakov and L.I.Dautova.

Dokl. Akad. Nauk SSSR, Vol. 132, No. 2, 333-5 (May 11, 1960). In Russian.

The paper points out marked changes in plasticity, electrical conductivity and thermal expansion occurring at about the same temperatures (120° and 180°C). The results of an accurate X-ray study of the lattice parameters, c and a, are plotted, to show any changes in the ratio c/a. This has a jump at 120°C, and a break slope at 180°C. No further analysis is offered, but the authors conjecture that seconder-order transitions associated with "spin-ordering" may be concerned.
I.D.C.Gur

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13497

ON THE DYNAMICAL THEORY OF DIFFUSION IN CRYSTALS. V. RANDOM-WALK TREATMENT OF T HEAT OF TRANSPORT.

A.R.Allnatt and S.A.Rice.

J. chem. Phys., Vol. 33, No. 2, 573-8 (Aug., 1960).

For Pt IV, see Abstr. 7862 of 1960. The heat of transport in crystalline medium is calculated from the flux of matter in a com bined temperature and concentration gradient. The use of a rand walk model leads to the prediction that the heat of transport is exactly equal to the activation energy for motion. This predictio is in excellent agreement with the measurements of Patrick and Lawson of vacancy motion in AgBr. The dynamical interpretatio the theory presented is briefly discussed.

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13498

THERMAL AND ELECTRICAL PROPERTIES OF AR IRON AT HIGH TEMPERATURES.

M.J.Laubitz.

Canad. J. Phys., Vol. 38, No. 7, 887-907 (July, 1960).

Thermal and electrical conductivity, thermoelectric power versus platinum, and thermal expansion of Armco iron were dete mined in the temperature range of 0°C to 1000°C. All these properties show a discontinuous change at the α—γ transition of iron and a change in slope at the Curie point. These measurements were carried out as a contribution to a co-operative determinatio of thermal conductivity of Armco iron at high temperatures.

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13499

THERMAL RESISTANCE DUE TO POINT DEFECTS HIGH TEMPERATURES.

P.G.Klemens.

Phys. Rev., Vol. 119, No. 2, 507-9 (July 15, 1960).

An expression is obtained for the lattice thermal conductivit at high temperatures in the limit when the scattering of phonons point defects is stronger than by umklapp processes. The latter limit the phonon mean free path at low frequencies and most of th heat is transported at frequencies such that the point defect and umklapp mean free paths are equal. The conductivity varies as $(AT)^{-1/2}$, where A is proportional to the strength of the point defe scattering, T is the temperature. The theory is in rough agreem with the thermal conductivity of Ge—Si alloys, measured by Steel and Rosi.

539.2 : 536

13500

THE PROBLEM OF THERMAL CONDUCTIVITY AND ABSORPTION OF SOUND IN SUPERCONDUCTORS.

V.Z.Kresin.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1947-8 (June, 1959). In sian. English translation in: Soviet Physics—JETP (New York), 36(9), No. 6, 1385 (Dec., 1959).

The results are briefly given, together with certain numerical es, of a theoretical investigation into the absorption of sound in perconductor and into the allied problem of the effect of the tron–phonon interaction on the electronic thermal conductivity perconductors. L.Mackinnon

539.2 : 536.48

3501

ANISOTROPY OF THE ABSORPTION COEFFICIENTS OF ULTRASONICS IN SUPERCONDUCTORS.

.Bezuglȳi, A.A.Galkin and A.P.Korolyuk.

eksper. teor. Fiz., Vol. 36, No. 6, 1951-2 (June, 1959). In sian. English translation in: Soviet Physics—JETP (New York), 36(9), No. 6, 1388-9 (Dec., 1959).

70 Mc/s ultrasound was propagated along the fourfold and two- axes of symmetry of a tin single crystal and its attenuation ied as a function of temperature between 2.1° and 3.73°K for normal and superconducting states. The temperature depen- e of the ratio of the two absorption coefficients is found to differ e two cases, being nearer to that expected for an isotropic metal n propagation is along the fourfold axis. L.Mackinnon

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.3502

FERMI SURFACES OF GOLD AND SILVER FROM ULTRASONIC ATTENUATION.

/.Morse, A.Myers and C.T.Walker.

s. Rev. Letters, Vol. 4, No. 12, 605-7 (June 15, 1960).

An oscillatory variation of ultrasonic attenuation in a magnetic d occurs because of geometrical coincidences between certain tron orbits and the periodic electric fields accompanying the nd waves. The period P in $(H\lambda)^{-1}$ is determined by the momentum rpendicular to H and to the propagation vector k of the sound e at those parts of the Fermi surface where this momentum is remal, $P = e/2cp$. Such oscillations were observed at 4.2°K in gle crystals of Au and Ag at frequencies up to 154 Mc/s. From isurements with waves propagated along various crystallographic ections, it was found that the Fermi surfaces in Au and Ag con- the Brillouin zone boundary in the [111]-direction. In gold, the of the contact area and the shape of the "neck" joining it to the n body of the surface were obtained directly. L.Pincherle

539.2 : 534.26

13503

ULTRASONIC SCATTERING AND ATTENUATION IN POLYCRYSTALLINE COPPER AND α-BRASS.

V.Krautkopf.

Acoust. Soc. Amer., Vol. 32, No. 7, 824-35 (July, 1960).

The ultrasonic pulse-echo technique has been employed to study ttering and attenuation in polycrystalline copper and α-brass. cimens in the form of cylindrical rods were annealed to various in sizes and tested at frequencies between 100 kc/s and 18 Mc/s, responding to scatterer circumference to wavelength ratios $/\Lambda$) from 10^{-3} to 1.6. The primary objectives of this investigation e to study the scattering process by direct observation of the ttered radiation, and to study the associated attenuation under ditions not previously amenable to measurement; these included es where pulse patterns were complicated by excessive scattering by mode dispersion. A preliminary investigation of the compli- ions attending the propagation of acoustic pulses was performed steel rods over a range of specimen radius to wavelength ratios Λ) similar to that to be covered in the later work. Pulse patterns e found to be relatively free from complication for $a/\Lambda<0.1$, and 0, approximately. In the intermediate range, the distribution of input energy among the various vibration types was found to vary h a/Λ, and with the details of the excitation. At low $a/\Lambda(<0.2)$, ere solutions of the Pochhammer frequency equation predict only mode of vibration for the rod, an additional mode was observed. s mode corresponded in timing to a shear mode generated upon lection of the predicted mode, and can be accounted for by consi- ing those roots of the frequency equation corresponding to Bessel ctions of imaginary argument. To avoid the complications due to de dispersion, the scattering experiments were designed to measure tically backscattered radiation, i.e., the scattered sound that ived at the detector before any of the modes could effect a round . The observed scattering levels were in reasonable agreement h theoretical expectations (based on Bhatia's theory for scattering he long wavelength region), except at low $\pi D/\Lambda$ where the back- ttering was seen to decrease with increasing frequency. The son for this discrepancy is not yet definitely established, but it is ieved to be a manifestation of propagation phenomena associated h the presence of attenuated vibrations in lossless media. Attenuation measurements were performed with pulses of duration comparable to the length of the specimen. This, combined with the high scattering ability of the medium, results in a pulse pattern whose envelope masks the details of the mode pattern. The rate of decay of this envelope corresponds to the attenuation of scattered sound and hence characterizes the intrinsic absorption properties of the metal. At $\pi D/\Lambda \sim 10^{-1}$ the energy attenuations were approximately 3×10^{-3} dB/grain for copper and approximately 3×10^{-4} dB/grain for α-brass. Comparison of the experimental data with the principal attenuation mechanisms operative at these frequencies showed the observed attenuation to vary over most of the range in the manner expected for elastic hysteresis damping.

539.2

13504

MAGNETO-ATTENUATION OF SOUND IN SEMIMETALS: LONGITUDINAL WAVES. M.J.Harrison.

Phys. Rev., Vol. 119, No. 4, 1260-9 (Aug. 15, 1960).

The calculation of the magnetic field dependence of ultrasonic attenuation in a semimetal is discussed on a simple model of its band structure. The results are applied to the case where the electron and hole mean free paths are large compared to the wavelength of sound. A series of oscillations and a large peak in the attenuation as a function of magnetic field are derived. The oscillations are geometric resonances of the type previously derived for metals, and the large peak is associated with the presence of density waves in the electron-hole carrier gas. The theoretical results are discussed, compared with experimental data, and found to agree semiquantitatively with the latter.

539.2

13505

THE POSSIBILITY OF INVESTIGATING THE DENSITY OF DISTRIBUTION OF PHONONS IN NON-CUBIC CRYSTALS WITH THE AID OF INCOHERENT NEUTRON SCATTERING. V.S.Oskotskii.

Fiz. tverdogo Tela, Vol. 2, No. 4, 701-3 (April, 1960). In Russian.

The differential cross-section for the incoherent inelastic scattering of neutrons by non-cubic crystals depends on the polarization of the phonons. It is shown that the sum of the cross-sections at a small number of coupled directions does not depend on the polarization, but only on the simpler properties of the crystal, and on the frequency distribution of the phonons.

R.B.Stinchcombe

539.2

13506

PHONON SCATTERING IN KCl–KBr SOLID SOLUTIONS AT LOW TEMPERATURES. W.S.Williams.

Phys. Rev., Vol. 119, No. 3, 1021-4 (Aug. 1, 1960).

The scattering of phonons by point defects at liquid helium temperatures was studied. Single crystals of KCl–KBr solid solutions were employed, since it is known that the Cl^- and Br^- ions are randomly distributed in the anion lattice sites. An addition of 1 mole % of KBr reduced the conductivity of KCl by a factor of three. For all the crystals measured, including pure KCl and pure KBr, the thermal conductivity showed a maximum at the same temperature (5°K). Hence, point defects reduce the conductivity on both the high- and low-temperature sides of the maximum. For the mixed crystals the thermal conductivity was found to be related to the absolute temperature by the empirical formula $K = K_0 \exp(0.099\,T)$ for the temperature interval 6° to 16°K.

539.2

13507

ELECTROSTATIC INTERACTIONS IN AN ELECTRON–ION GAS AT HIGH DENSITY. T.Nishiyama.

Progr. theor. Phys., Vol. 21, No. 3, 389-408 (March, 1959).

The influence of the Coulomb interaction of electrons upon the electron–ion interaction and the ionic oscillation of an electron–ion gas at high density is considered by utilizing a method of normal modes on the one hand and a collective description on the other. The so-called Froelich Hamiltonian for the electron–phonon interaction is derived by eliminating the electronic plasmon from the total Hamiltonian completely. As the interactions between electron pairs with opposite momenta and with different spins which are essential to the superconductivity are discarded in the method of normal modes, the results obtained by this method are considered as valid only for the normal state. These important interactions of electron pairs can be taken into account in the collective description, by means of which the electron–phonon Hamiltonian with the screened interaction of electrons is obtained. Further, a dispersion equation for the system is obtained by the "sound approximation" proposed previously which proves to be equivalent to Sawada's pair theory for small momentum transfers.

The dispersion equation obtained exhibits a "metastable" state corresponding to the phonon excitation. The eigenfrequency and the decay time are estimated for a certain region of wave numbers. By the perturbation expansion of the density matrix in the sound approximation a relationship between the correlation energy and the dispersion equation is pointed out and the role of the Coulomb interaction of electrons is illustrated graphically.

539.2

13508 THE EXCITON—LATTICE INTERACTION AND THE LINE SHAPE OF THE EXCITON ABSORPTION BAND.

Y.Toyozawa.

Prog. theor. Phys., Vol. 19, No. 2, 214-16 (Feb., 1958).

Investigation of line shape for exciton absorption is considered a powerful method of obtaining information on band structure and strength of phonon—exciton interaction from experimental data. The Hamiltonian for the latter is derived and then the exciton line shape. This is Lorentzian for small exciton mass and low enough temperature, provided the wave vector is zero at the top or bottom of the exciton band. For large mass and high temperature a Gaussian shape is obtained. The subsequent fate of the exciton on creation is calculated from comparison of the above derivations with experiment. G.F.J.Garlick

539.2

13509 BROADENING OF SPIN—PHONON RESONANCE LINES BY EXCHANGE AND MAGNETIC DIPOLE INTERACTIONS.

R.Loudon.

Phys. Rev., Vol. 119, No. 3, 919-21 (Aug. 1, 1960).

The second and fourth moments of the three principal ultrasonic free-spin absorption lines are calculated using a phenomenological form for the spin—phonon interaction. Both exchange and dipole interactions are taken into account, and it is found that exchange causes increased line width in all three cases. For the line at the Larmor frequency, the moments are compared with those for the corresponding photon absorption line, for which exchange narrowing occurs.

539.2

13510 THE CALCULATION OF THE OSCILLATOR STRENGTH FOR TRANSITIONS OF IMPURITY ELECTRONS IN UNIAXIAL CRYSTALS.

A.I.Ansel'm and L.I.Korovin.

Zh. tekh. Fiz., Vol. 27, No. 7, 1584-6 (July, 1957). In Russian.

Dipole transitions from the ground state are considered. Selection rules are given and the dependence of the oscillator strength on a parameter β is calculated using the variational procedure introduced earlier by the authors.[Zh. tekh. Fiz., Vol. 25, No. 12, 2044 (Oct., 1955)]. $\beta = \epsilon_1 m_1/\epsilon_2 m_2$ where ϵ_1 and ϵ_2 are the two dielectric constants of the crystal and m_1 and m_2 are the two effective masses. R.B.Stinchcombe

539.2

13511 EFFECT OF IMPURITIES ON THE ELECTRONIC DENSITY IN METALS. I.

E.Daniel.

J. Phys. Radium, Vol. 20, No. 10, 769-83 (Oct., 1959). In French.

A theoretical study of the changes of electron density in a free-electron gas due to a central perturbing potential. It is shown that, even for short-range potentials, the density variations allow for fairly long range interactions in a metal, for their amplitude decreases only as the inverse square of the distance from the diffusing centre. Almost all the screening charge is concentrated in the region where the potential is important; outside this region, the local variations of density may be important even if their integral over the space is small. Finally, the use of a square-well potential to represent an atom dissolved in a metal, as long as it obeys the phase-shift sum-rule, is justified and its meaning is explained. These results are used to explain the variations of the Knight shift of the matrix in a dilute alloy. The theory accounts quantitatively for these variations, being proportional to the concentration of the alloy, as well as for the broadening of the resonance lines.

539.2

13512 EFFECT OF IMPURITIES ON THE ELECTRONIC DENSITY IN METALS. II.

E.Daniel.

J. Phys. Radium, Vol. 20, No. 11, 849-59 (Nov., 1959). In French.

The theory developed in Pt I is applied to the dissolved atoms themselves. The effect of screening on the Knight shift of the solute atoms in an alloy is studied. It is shown that the screening by the conduction electrons accounts for the approximate uniformity of the positron lifetime in a metal, without formation of positronium. The importance of the screening effect in photon angular correlati is emphasized. A similar computation is carried out of what may called the Knight shift of a μ-meson in a metal. Finally, the impo tance of the screening effect on the soft X-ray spectra of metals i investigated.

53

13513 GIANT SPIN DENSITY WAVES.

A.W.Overhauser.

Phys. Rev. Letters, Vol. 4, No. 9, 462-5 (May 1, 1960).

It is normally assumed that the Hartree—Fock ground state f a Fermi gas is the one with doubly occupied one-electron states within the Fermi sphere. It is shown for a one-dimensional mode with δ-function interactions that states of lower energy corresponding to static spiral spin density waves exist within the Hartre Fock approximation. A generalization of this result to a three-dimensional gas with Coulomb interactions is indicated and its significance discussed. D.M.Edwar

53

13514 PLANE WAVE METHOD WITH A MODIFIED POTENTIAL FIELD.

R.Gáspár.

Acta phys. Hungar., Vol. 9, No. 1-2, 79-95 (1958).

A new method is developed for the determination of the energ band spectrum of electrons in metals. An essential advantage of the method is that it use plane waves. This is made possible by the introduction of a "repulsive" potential, which takes care of the high kinetic energy of the eigenfunction oscillating in the neighbourhood of the nuclei. Thus the valence electrons can be treated as if they filled the Brillouin zones gradually from the lowest Brillouin zone. This also means that in this model the eigenfunctions of the electrons can be well approximated by the linear com nation of a few plane waves. The number of the rows and columns of the secular equations arising at the degenerate points in the neighbourhood of the boundaries of the Brillouin zones is low. The problems associated with the repulsive potential in the matri components of the secular equation are investigated in detail. It is shown that these matrix components are such that they do not alter the qualitative structure of the secular equation. The value of the matrix components of the Hamiltonian varies in the Brillou zone from place to place.

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13515 VALENCE STRUCTURE OF THE HIGHER BORIDES.

W.N.Lipscomb and D.Britton.

J. chem. Phys., Vol. 33, No. 1, 275-80 (July, 1960).

An attempt is made to systematize the valence orbital structu of the boron frameworks in MB_2, MB_4, MB_6, MB_{12}, $B_{12}C_3$, and elementary boron.

53

13516 ON THE STABILITY OF NON-STOICHIOMETRIC COMPOUNDS.

A.J.Frueh, Jr.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 334-5 (Oct., 1959).

See Abstr. 12247 of 1959. Discusses the consequences of an excess of electrons over the capacity of the valence band in the stoichiometric form of a compound; it is shown that this may caus a non-stoichiometric form to be more stable, and the particular case of stromeyerite (AgCuS) is explained in this way. J.Hawg

53

13517 ELECTRON WAVE FUNCTIONS IN METALLIC POTASSIUM.

J.Callaway.

Phys. Rev., Vol. 119, No. 3, 1012-13 (Aug. 1, 1960).

Wave-functions to order k^2 are presented for electrons in metallic potassium. The calculation is an application of the cellul method. The potential was derived from a self-consistent field an contains exchange effects.

53

13518 CONDUCTION ELECTRONS IN SODIUM TUNGSTEN BRONZE.

J.M.Keller.

J. chem. Phys., Vol. 33, No.1, 232 (July, 1960).

The vanishing of the Knight shift of Na^{23} in Na_xWO_3 is interpreted in terms of an inverted conduction band.

53

13519 THE HOLE PART OF THE FERMI SURFACE IN BISMUTH.

N.B.Brandt.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1355-6 (April, 1960). In Russian.

By measuring the anisotropy of the magnetic susceptibility of

nuth, the shape and size of the Fermi surface of the hole distribu-
are determined, as well as the hole concentration and effective
s in various directions. The results are found to agree with
r experiments. A.M.Green

539.2 : 539.12

13520

ON POSITRONIUM IN METALS.

H.Kanazawa.

gr. theor. Phys., Vol. 20, No. 3, 400-1 (Sept., 1958).

An electron—positron system is considered in the non-relativistic
merfeld free-electron approximation, and the properties of
itronium in metals investigated. S.J.St-Lorant

539.2

13521

ON THE APPROXIMATE FORMULATION OF THE ORTHOGONALIZED PLANE-WAVE METHOD.

ntončík.

ch. J. Phys., Vol. 10, No. 1, 22-8 (1960).

An approximate method, analogous to the orthogonalized plane-
e (OPW) method, is used to calculate the energy at a number of
ts in the Brillouin zone of lithium and the results are compared
the energy values calculated by the OPW method. Some of the
eral properties of the matrix elements of the repulsive potential
discussed and correlation with other methods carried out.

539.2

13522

THE PRESENT STATE OF THE EXCITON PROBLEM.

M.Balkanski.

hys. Radium, Vol. 19, No. 2, 170-82 (Feb., 1958). In French.

A theoretical treatment of the exciton problem with an indication
ossible developments of the theory. The exciton propagation can
egarded as analogous to multiple scattering of light in optical
onance. The photon absorbed by an atom, after propagation in the
n of an excitation wave, can be re-emitted and re-absorbed by
her atom. When the frequency of this absorption and emission
igh, and if it is produced in coherence, this mechanism can
cribe the exciton notion. Some experimental results concerning
creation and annihilation of excitons in solids are also reviewed.

539.2

13523

EXCITON AND PLASMON IN INSULATING CRYSTALS.

C.Horie.

gr. theor. Phys., Vol. 21, No. 1, 113-34 (Jan., 1959).

The relation between an exciton and a plasmon in insulators is
estigated from the view-point of an electron—hole pair approxi-
ion. It is shown that the usual exciton model is valid in the
ulator having appreciably localized wave-functions and that if
wave-functions are not appreciably localized but rather extended
asmon-like excitation becomes possible and appears above the
tinuum pair-band besides the exciton level below it. This
aviour is discussed in comparison with experimental data.

539.2

13524

LCAO TREATMENT OF EXCITON STRUCTURE IN ALKALI HALIDE CRYSTALS.

R.A.Pappert.

s. Rev., Vol. 119, No. 2, 525-32 (July 15, 1960).

A Heitler—London treatment is applied to the transfer mech-
sm which has been traditionally associated with the fundamental
orption of alkali halide crystals. In particular, detailed calcula-
s are made for NaCl using the free atom Na 3s Hartree—Fock
tion for the one-electron transfer function and the free ion
tree—Fock solutions for the remaining one-electron functions.
energy and oscillator strength so determined are irreconcilable
experiment, showing that the free atom Na 3s function cannot
used in conjunction with the transfer model if the model is to
d sensible results. In a very semiquantitative way it is shown
an electron-hole overlap integral of about 0.1 coupled with
rhauser's exciton model leads to a doublet structure which is
greement with experimental results for many of the chlorides,
mides, and iodides. These findings do not distinguish the transfer
del from the "excitation model".

539.2

13525

ANALYSIS OF MIXED AMBIPOLAR AND EXCITON DIFFUSION IN CdS CRYSTALS.

Diemer, G.J.van Gurp and W.Hoogenstraaten.

lips Res. Rep., Vol. 14, No. 1, 11-28 (Feb., 1959).

See Abstr. 6256 of 1959. Measurements were made of the spec-
l response of the diffusing excitation, and the temperature de-
dence of the diffusion length. The propagation velocity of diffus-
photoconductivity is derived assuming a mixed ambipolar and
exciton diffusion mechanism. For a particular crystal, the exciton lifetime was 80 μsec and the exciton diffusion constant 1100 cm^2 sec^{-1} at room temperature, but results varied for different crystals. J.Franks

539.2

13526

THE DESTRUCTION OF EXCITONS IN THE ELECTROSTATIC FIELDS OF DEFECTS IN IONIC CRYSTALS.

M.Trlifaj.

Czech. J. Phys., Vol. 10, No. 1, 7-13 (1960). In German.

A theory is given for the destruction of excitons due to ionization by electrostatic fields at defects. The effective cross-sections are determined for a small and a large exciton mean free path, depending on the exciton interaction with phonons. The results were used in a study of exciton destruction at a vacancy next to a Cu ion in Cu$_2$O crystals with excess O. J.Franks

539.2

13527

[111] DIRECT TRANSITION EXCITON AND MAGNETO-REFLECTION IN GERMANIUM.

B.Lax.

Phys. Rev. Letters, Vol. 4, No. 10, 511-12 (May 15, 1960).

Theoretical. The existence of a new exciton in germanium, consisting of an electron and a hole located at the boundary of the Brillouin zone along the [111] direction, is predicted, and it is suggested that reflection experiments at liquid He temperatures in high magnetic fields and with high-resolution spectrometers should detect it, and provide information on the effective mass parameters of the holes, on the g-factors of both electrons and holes and their anisotropies, and a measurement of the binding energy of the exciton, besides an accurate determination of the energy difference between the two levels concerned. The values of some of these quantities are predicted, and various experimental aspects are specified. The line shape should present maxima corresponding to the transitions between Landau levels. It is also suggested that the transition considered should be advantageous for use in an optically excited cyclotron resonance maser. L.Pincherle

539.2

13528

CYCLOTRON RESONANCE IN INDIUM AT A FREQUENCY OF 9300 Mc/s.

P.A.Bezuglȳi and A.A.Galkin.

Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1480-1 (Nov., 1959). In Russian.

The ratio of the surface resistance of the specimens in a magnetic field to the resistance with no field, was investigated as a function of magnetic field strength at 4.2 and 2.45°K. The effective electron mass is found to be 0.8-0.9 m_0.. K.N.R.Taylor

Defect Properties

539.2

13529

IMPERFECTIONS OF THE CRYSTAL STRUCTURE OF HEAVILY DEFORMED NIOBIUM.

L.I.Lȳsak and L.V.Tikhonov.

Fiz. Metallov i Metallovedenie, Vol. 9, No. 1, 119-23 (1960). In Russian.

Hardness measurements and X-ray diffraction analysis of Nb, subjected to cold, plastic deformation ($\epsilon > 70\%$), showed that the difference between hardness, measured in the directions parallel and perpendicular to the direction of rolling, is associated with similar differences in the magnitude of the lattice distortion and size of the blocks. M.H.Sloboda

539.2

13530

INTRODUCTION — DEFECTS IN SILICAS.

G.J.Dienes.

J. Phys. Chem. Solids, Vol. 13, No. 3-4. 272-8 (June, 1960).

As an introduction to the field of defect structure of quartz and vitreous silica the nature of bonding in silicas is reviewed briefly and a comparison is made between the crystalline and amorphous structures. It is found instructive to compare the status of the field with that of the typical ionic crystals, such as the alkali halides. Defects in silicas are then discussed more specifically under the following headings: (i) types of defect expected in silicas, (ii) production of defects by nuclear radiations and (iii) comparison of defects in crystalline and amorphous silicas on the basis of optical studies.

539.2

13531 DIRECT OBSERVATION OF SUPERDISLOCATIONS IN A SUPERLATTICE.

M.J.Marcinkowski, R.M.Fisher and N.Brown.
J. appl. Phys., Vol. 31, No. 7, 1303 (July, 1960).

According to Koehler and Seitz (1947), the dislocation configuration in an ordered alloy should consist of pairs of ordinary dislocations (superdislocations), the two members of each pair being separated by an antiphase boundary. These dislocation pairs have now been observed by transmission electron microscopy on suitably prepared films of $AuCu_3$. The width of the superdislocations was found to be about 130 A. L.Pincherle

539.2

13532 DISLOCATION DAMPING IN METALS.

D.H.Niblett and J.Wilks.
Advances in Phys., Vol. 9, 1-88 (Jan., 1960).

The subject of this review is discussed under four main headings: (a) the peak at low temperatures in the internal friction versus temperature curve in cold worked face-centred cubic metals (the Burdoni Peak); (b) amplitude dependent internal friction at low and medium temperatures (approx. 300°K); (c) internal friction at high temperatures; (d) amplitude-independent internal friction at low strain amplitudes. The measurements and the effects of such factors as strain amplitude, cold work, purity, neutron irradiation frequency and annealing are discussed in relation to current theories. The introduction includes a brief description of the torsion pendulum, resonant bar and the ultrasonic pulse method of measuring internal friction and also includes a description of the principal ways that damping can arise independently of the presence of dislocations. J.E.Caffyn

539.2

13533 SOME ELASTIC PROPERTIES OF A SCREW DISLOCATION WALL.

J.C.M.Li and C.D.Needham.
J. appl. Phys., Vol. 31, No. 8, 1318-30 (Aug., 1960).

The stress fields of an infinite and a finite screw dislocation wall are given and from them the interactions of the screw dislocation walls with parallel and nonparallel dislocations have been studied. The nature of the penetration through a screw dislocation wall of a number of parallel screw dislocations driven by external stress and the possible stress concentration for a pile-up against the wall are discussed in detail. The forces exerted by a screw dislocation wall on nonparallel edge and screw dislocations are calculated. The significance of the local torques due to these forces as a possible mechanism for the screw dislocation wall to become a source for generating dislocations is pointed out. The metastability of the screw dislocation walls is demonstrated and their strain energy is estimated and compared with that of the edge dislocation walls. It is concluded that the resistance to penetration of a dislocation wall increases in the following order: infinite edge dislocation wall, finite edge dislocation wall, finite screw dislocation wall, and infinite screw dislocation wall. It is also found that the strength of a dislocation wall increases with its surface strain energy.

539.2

13534 A UNIQUE CORRELATION BETWEEN ETCH FIGURES AND DISLOCATIONS.

Sun' Zhui-Fan [Sun Jui-Fang] and M.P.Shaskol'skaya.
Kristallografiya, Vol. 4, No. 4, 590-93 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 4, 550-4 (April, 1960).

The number of etch pits along the birefringent bands in plastically deformed rock-salt is related to the difference between the amounts by which those bands are displaced when they emerge at the side of the crystal.

539.2

13535 ETCH PITS AND DISLOCATIONS IN CADMIUM SULPHIDE CRYSTALS.

J.Woods.
Brit. J. appl. Phys., Vol. 11, No. 7, 296-302 (July, 1960).

A technique is described for producing dislocation etch pits on (0001), (000$\bar{1}$) and {10$\bar{1}$0} growth faces of cadmium sulphide crystals. Methods are also described whereby the dislocations are decorated by precipitation of either gallium or copper. The strongest proof that the etch pits are formed where dislocation lines cut the free surfaces is provided by (1) the characteristic etch pattern formed after indentation; (2) the densities of etch pits in intersecting low-angle grain boundaries; and (3) the coincidence of etch pits and decorated lines. Various other observations support the main evidence. In conclusion. it is shown that the dislocation content can play an important part in determining some of the electrical properties of the crystals. In particular, copper is rendered ineffective as an acceptor by precipitation, and dislocations introduced in cadmium sulphide/chlorine crystals by plastic bending lea to the formation of acceptors.

539

13536 INVESTIGATION OF THE INFLUENCE OF CERTAIN FACTORS ON THE FORMATION OF DISLOCATIONS DURING CRYSTALLIZATION AND THEIR STATE IN SINGLE-CRYSTAL GERMANIUM.

A.D.Belyaeu, V.N.Vasilevskaya and E.G.Miselyuk.
Fiz. tverdogo Tela, Vol. 2, No. 2, 227-34 (Feb., 1960). In Russian.

Deals with the factors influencing the dislocation density in melt-grown crystals such as the dislocations in the seed crystal, the impurity concentration in the melt and the solubility of the impurity (Sb, Ag, Cd, Fe). Experimental results on the effects of annealing show that the dislocations will move towards low-angle boundaries or the surface of the crystal at 700-800° C, while at very high temperatures, near the melting point, the dislocations can be removed by their motion towards the edges of the specimen The dependence of the minority carrier lifetime on the resistivity and the dislocation density is discussed. Figures include nine plates. W.Bardsl

539

13537 THE INTERACTION OF DISLOCATIONS IN SILICON OBSERVED WITH THE AID OF SHADOWING.

L.S.Milevskii.
Kristallografiya, Vol. 4, No. 5, 785-6 (Sept.-Oct., 1959). In Russi English translation in: Soviet Physics—Crystallography (New York Vol. 4, No. 5, 742-3 (May, 1960).

Dislocations in Si single crystals were decorated with Cu and photographed under an infrared microscope. Curved dislocations festoon formation were observed, caused by the intersection of screw dislocations. J.Fran

539

13538 DISLOCATIONS IN SILICON CARBIDE.

S.Amelinckx, G.Strumane and W.W.Webb.
J. appl. Phys., Vol. 31, No. 8, 1359-70 (Aug., 1960).

The dislocation structure of type 6H hexagonal silicon carbide has been studied by etching combined with optical microscopy and by X-ray diffraction microscopy. The validity of the conventional etching technique for identification of the sites of the intersection of dislocations with (0001) surfaces has been established. Howeve high sensities of dislocations lying in (0001) planes and hence heretofore undetected by etching techniques were often observed by diffraction microscopy. Dislocations with [11$\bar{2}$0] vectors have now been found with evidence for slip both on basal planes and on a "puckered" pyramidal plane. Pileups formed by slip and dislocat walls formed by climb were also observed. Silicon carbide shows many of the characteristics of more conventional plastically deformable materials.

539

13539 THE DISTRIBUTION OF DISLOCATIONS IN SILICON IRON SINGLE-CRYSTALS GROWN FROM THE MELT.

B.Šesták.
Czech. J. Phys., Vol. 10, No. 2, 91-103 (1960).

The distribution of dislocations in a crystal of an Fe—4.2% Si alloy was studied microscopically and by X-ray diffraction after t dislocations were rendered visible by anodic dissolving. The dislocations were also studied inside the crystal by successively grin ing the surface. The density of the dislocations inside the blocks was determined by calculation from microphotographs, the density of the dislocations forming the boundaries between the blocks by measuring the angles between the lattices of neighbouring blocks. It is found that the dislocations are distributed very unevenly in th crystal and most of them form complicated boundaries of blocks, similarly as with ionic crystals. The distribution of dislocations also discussed from the point of view of their formation, and conclusions are reached as to the preparation of single crystals havin a smaller number of dislocations.

539

13540 DISLOCATIONS IN METAL CRYSTALS GROWN FROM THE MELT.

C.Elbaum.
J. appl. Phys., Vol. 31, No. 8, 1413-15 (Aug., 1960).

Dislocation densities and arrangements were studied, as a function of specimen thickness, in metal crystals grown from the lt. Aluminium crystals containing fewer than 10^4 dislocations cm^2 were produced by this method. The results of this study consistent with the mechanism of collapsing vacancy disks for nerating dislocations in crystals grown from the melt. It was nd, in aluminium, that below a dislocation density of about 10^6 es per cm^2, dislocations remain in a random network and do not m sub-boundary arrays. The range of effective interaction ween dislocations, to form arrays, thus appears to be limited to average distance between dislocations when the density is about lines per cm^2, or about 10 μ.

539.2

13541 **SPIRAL DISLOCATIONS ON GLASS FRACTURE SURFACES.** W.C.Levengood and T.S.Vong.
appl. Phys., Vol. 31, No. 8, 1416-21 (Aug., 1960).

Within a certain range of composition spiral defects were served on etched soda—lime—silica glasses. The patterns des- bed spirals of Archimedes and appeared to originate from inter- tial defects in the glass. Mutual stress influence effects were served. The hypothesis of an existing torque field around the inter- tial defects was useful in explaining the spiral mechanism. plication of mechanical torque stresses produced the spiral effect. some cases it appeared feasible to apply stress energy relation- ps developed from dislocation theories to these minute flaw terns. A dynamic spherical indenter technique was developed to dy structural variations in these glasses. The lengths of flaws duced by a rolling indenter were found to be sensitive to changes the silica content of the glasses and less affected by variations in soda—lime ratio. The effects of heating and crystallization were o studied.

539.2

13542 **THE RELATION OF ORIENTATION TO KINKING LIMIT FOR MONOCRYSTALS.**
.Regel' and G.V.Berezhkova.
istallografiya, Vol. 4, No. 5, 761-7 (Sept.-Oct., 1959).
Russian. English translation in: Soviet Physics—Crystallography ew York), Vol. 4, No. 5, 718-23 (May, 1960).

Monocrystals of CsI and of TlBr—Tl I were used to study king. The results are examined in the light of the law of critical king stresses. It is found that the critical stress depends very ch on the crystallography orientation and does not obey the above . It is considered that the deviations occur because slip and rdening precede kinking.

539.2

13543 **THE MEASUREMENT OF INTERNAL STRESSES IN CRYSTALS OF SYNTHETIC CORUNDUM.**
L.Indenbom and G.E.Tomilovskii.
istallografiya, Vol. 3, No. 5, 593-9 (1958). In Russian. English nslation in: Soviet Physics—Crystallography (New York), Vol. 3, . 5, 599-605 (Dec., 1959).

Formulae are given for calculating the stresses acting perpen- ular to the optic axis of a crystal of corundum, from data of hoscopic or conoscopic observation of optical anomalies. amples of a quantitative determination of the stresses are pre- nted. The presence in the crystals of a compressed, and not an panded core, is established. This conclusion is confirmed by an estigation of a split rod.

539.2

13544 **STATIC AND IMPACT DEFORMATION IN MUSCOVITE.** B.I.Revnov and E.O.Shvaikovskaya.
istallografiya, Vol. 4, No. 5, 756-60 (Sept.-Oct., 1959).
Russian. English translation in: Soviet Physics—Crystallography w York), Vol. 4, No. 5, 714-17 (May, 1960).

Deformation tests are described. Impact and pressure figures both be produced by impact, the latter if the impact is very ong. They may appear together from a single blow.

539.2

13545 **OBSERVATIONS OF MACROMOSAIC SUBSTRUCTURES IN LEAD ["STRIATIONS"].**
F.Sekerka, G.F.Bolling and W.A.Tiller.
nad. J. Phys., Vol. 38, No. 6, 883-5 (June, 1960).

Single crystals of Pb and Pb—Ag alloys of 10^{-4} to 10^{-2} at.% Ag, re grown by horizontal zone melting under various ambient tem- ratures. The influence of the temperature on the array formation l the influence of several freezing velocities v, was studied. With very pure material no striations are produced even with a v temperature gradient G in the liquid at the interface. (2) With crystals containing some measurable solid solute, concentration formation is inhibited only by high v, or low G. (3) The incubation distance for striations increases with decreasing G. (4) The width of the striations and the misorientation decrease with G/v decreasing. The conclusion reached is that in high purity lead, insufficient dislocations were grown into the crystal to cause array formation; in Pb—Ag alloys with well-developed cellular substructure the solute segregation decreases the mobility of dislocations, array formation cannot occur. H.E.Schmid

539.2

13546 **INVESTIGATION OF ULTRAMICROSCOPIC INHOMOGENEITIES OF PLASTICALLY DEFORMED ROCKSALT. II.** R.I.Garber and L.M.Polyakov.
Fiz. tverdogo Tela, Vol. 2, No. 5, 974-81 (May, 1960). In Russian.

For Pt I see Abstr. 799 of 1957. The scattering of light by rocksalt specimens in compression, tension, bending and shear was measured, and observations were made on the specimens in the electron microscope. The results were related to the existence of defects in the specimens. R.F.S.Hearmon

539.2

13547 **MULTIPLE SLIP IN ZINC AT ROOM TEMPERATURE.** L.I.Vasil'ev, K.L.Zaring and L.A.Kudryavtseva.
Kristallografiya, Vol. 4, No. 5, 768-72 (Sept.-Oct., 1959).
In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 724-7 (May, 1960).

Mosaic slip has been detected in grains of deformed zinc. The angles between the slip lines are such as to show that the basal $(0001)/[2\bar{1}\bar{1}0]$ and pyramidal $(01\bar{1}1)/[2\bar{1}\bar{1}0]$ slip systems are both active

539.2

13548 **MEASUREMENT OF THE EQUILIBRIUM CONCENTRATION OF LATTICE VACANCIES IN SILVER NEAR THE MELTING POINT.** R.O.Simmons and R.W.Balluffi.
Phys. Rev., Vol. 119, No. 2, 600-5 (July 15, 1960).

Relative changes in macroscopic length, $\Delta L/L$, and X-ray lattice parameter, $\Delta a/a$, of a 99.999% silver bar were measured from 14° to 956°C, using a rigid parallel pair of filar micrometer microscopes and a rotating single-crystal X-ray method. The expansions agree within experimental precision (about 1 : 10^5) at the lower temperatures. At the higher temperatures $(\Delta L/L-\Delta a/a)$ progressively increases, showing that atomic sites are added, corresponding to the thermal generation of vacancy-type defects. The concentration of added sites, $\Delta N/N = 3(\Delta L/L-\Delta a/a)$, at the melting point (obtained by a 4° extrapolation) is $(1.7 \pm 0.5) \times 10^{-4}$. This value is only 1/5.5 of the corresponding value previously found for aluminium by the same technique. For reasonable values of the binding energies of vacancy aggregates, it is concluded that more than 90% of these extra sites are present as single vacancies. For an entropy of formation of $(1.5 \pm 0.5)k$ an energy of formation for monovacancies of 1.09 ± 0.10 eV is obtained. This formation energy is slightly larger than half the activation energy for self-diffusion, as similar measurements have shown for aluminium, and as quenching experiments have indicated for gold.

539.2

13549 **QUENCHING OF LATTICE VACANCIES IN PURE SILVER.** M.Doyama and J.S.Koehler.
Phys. Rev., Vol. 119, No. 3, 939 (Aug. 1, 1960).

Quenching data on 99.999% pure silver gives the energy required to form a lattice vacancy to be 1.10 ± 0.04 eV. In addition, the data of Simmons and Balluffi (who obtained the vacancy concentration in equilibrium near the melting temperature) together with present data give the resistivity increase per atomic percent vacancies to be 1.3 ± 0.7 micro ohm cm.

539.2

13550 **THE DEPTH OF COLOURATION IN ALKALI-HALIDE CRYSTALS BOMBARDED BY ELECTRONS WITH ENERGIES FROM 6 TO 15 kV AT VARIOUS ANGLES OF INCIDENCE.**
A.R.Shul'man and É.P.Gel'.
Fiz. tverdogo Tela, Vol. 2, No. 3, 524-9 (March, 1960). In Russian.

When the electron beam is normal to the crystal face, the depth of coloration d in microns and the electron energy V in kV are related by: $d = 0.07\,V^{1.5}$, for NaF; $d = 0.055\,V^{1.5}$, for NaCl and KCl; $d = 0.035\,V^{1.7}$, for KBr. Varley's data for KCl (Abstr. 4180 of 1955) irradiated by electrons with energies from 300 to 11 000 kV appear to fit into the same formula. When the electron beam is not normal to the crystal face, the depth of coloration is greater than could be expected from simple cosine of the angle of incidence relationship and this indicates that scattering of electrons takes place. J.Adam

539.2 : 541.13

13551 CATIONIC MOVEMENT AND COLOUR CENTRE FORMATION DURING THE ELECTROLYSIS OF QUARTZ PLATES PERPENDICULAR TO THE C-AXIS.

H.H.Pfenninger and F.Laves.

Naturwissenchaften, Vol. 47, No. 12, 276 (1960). In German.

An electrolytic current, perpendicular to the c-axis, was obtained in quartz plates at 850°C, in dry N_2 or A, under a field of between 1.3 and 2.0 kV/cm. A movement of colour centres from the anode to the cathode was observed, the centres were due to Li impurity. The electrolytic current increased in the presence of water vapour or H_2. Movement of hydrogen ions was inferred from absorption measurements in the 2.95 μ band. J.Franks

539.2

13552 ELECTRICAL AND OPTICAL INVESTIGATION OF ABSORPTION CENTERS IN RUTILE SINGLE CRYSTALS.

K.G.Srivastava.

Phys. Rev., Vol. 119, No. 2, 516-20 (July 15, 1960).

Absorption centres in single crystals of rutile, causing relaxation spectra in the low-frequency range, can be produced by thermal quenching or optical irradiation at the edge of the characteristic absorption region (4200 A). They are only observed when the a.c. field is applied parallel to the optic axis. The temperature dependence of the main dispersion peak indicates an activation energy of 0.18 eV. Introduction of silver or copper by thermal diffusion did not produce low-frequency absorption maxima.

539.2

13553 DECREASE OF F-CENTER PHOTOCONDUCTIVITY UPON BLEACHING.

F.C.Hardtke, A.B.Scott and R.E.Woodley.

Phys. Rev., Vol. 119, No. 2, 544-9 (July 15, 1960).

A quantitative study of the rapid decrease in photoconductivity accompanying the relatively less rapid bleaching of F-centres in additively coloured KCl is reported. The experimental observations agree, except during very early stages of bleaching, with an equation for the variation of sensitivity with total light absorbed derived upon the assumption that negative-ion vacancies are created and traps of smaller cross-section are filled during bleaching. Except during early stages, where several kinds of traps may be present in low concentration, only one kind of trap other than the negative-ion vacancy need be considered. The effects of added divalent ions, both positive and negative, upon photoconductivity are reported.

539.2

13554 BREADTH OF THE F BAND IN NaCl.

A.M.Karo, C.W.McCombie and A.M.Murray.

Phys. Rev., Vol. 119, No. 2, 504-5 (July 15, 1960).

The breadth is calculated for various temperatures, primarily in order to investigate the status of the semiempirical configuration coordinate treatment of such problems. The main new feature of the calculation, which involves no adjustable parameters, is the use of the realistic normal modes employed in the Born—Blackman theory of specific heats. The eigenvectors as well as the eigenfrequencies of these modes are used. Modifications of the modes due to the missing ion at the F-centre are ignored. The coupling to the F-centre is determined from electrostatic forces on individual ions. Simpson's F-centre wave-functions are used and the calculated breadths are all about 85% of the experimental values. It is found that the main contributions to the breadth come from modes in a fairly small range of frequencies (much lower than the frequencies of the longitudinal optical modes considered in previous calculations) which includes the empirical configuration coordinate frequency. This last result helps to clarify the relation of the hypothetical configuration coordinate mode to the actual modes of lattice vibration.

539.2

13555 EFFECT OF PRESSURE ON COLOR CENTERS IN Ag^+-DOPED ALKALI HALIDES.

R.A.Eppler and H.G.Drickamer.

J. chem. Phys., Vol. 32, No. 6, No. 6,1734-8 (June, 1960).

The crystals studied include NaCl (two concentrations), KCl, and KBr. The resulting shifts are used to confirm the assignments of some peaks, and, in certain cases, to decide among conflicting interpretations.

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13556 EFFECT OF PRESSURE ON THE M CENTER IN ALK HALIDE CRYSTALS. S.Minomura and H.G.Drickamer

J. chem. Phys., Vol. 33, No. 1, 290-3 (July, 1960).

The effect of pressure to 52 800 atm was measured on the M-band in NaCl, KCl, KBr, and KI and on the R_2 and N bands in KCl. In general, the band peak shifts to higher frequency with increasing pressure for all bands. At the phase transition from f.c.c. to s.c. there is a blue shift in KCl, but a red shift in KBr and KI. It is suggested that the shift corresponds to a balance between contraction and polarizability effects. From an Ivey-type relation, it would seem that the M centre is somewhat less compre sible than the F centre. There is a marked increase in intensity of the M centre in the potassium halides in going through the phase transition from the f.c.c. to the s.c. lattice.

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13557 THE DIFFUSION EQUATION.

R.L.Fogel'son.

Fiz. tverdogo Tela, Vol. 2, No. 5, 902-7 (May, 1960). In Russian.

Shows that a correct hetero-diffusion equation should include the absolute concentration (rather than the relative one) of the diffusing substance. The use of such an equation produces a better agreement between experiment and theory. As a consequence two diffusion coefficients are needed to describe diffusion in a binary system. A.Tybulewi

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13558 A METHOD OF EVALUATING DIFFUSION COEFFICI- ENTS IN CRYSTALS. O.P.Manley.

J. Phys. Chem. Solids, Vol. 13, No. 3-4, 244-50 (June, 1960).

The mechanism of diffusion proposed by Rice is reconsidered with the aid of an extension of Kac's theorem. The analysis yields an activation energy which, as predicted by Zener, is simply relat to the minimal local deformation energy. It is also found that in contrast with Rice's treatment, the activation energy may be calcu ated directly from the atomic force constants without resorting to normal mode analysis.

53

13559 DIFFUSION OF DEUTERIUM IN DEUTERON-IRRADIATED COPPER.

M.T.Robinson, A.L.Southern and W.R.Willis.

J. appl. Phys., Vol. 31, No. 8, 1474-82 (Aug., 1960).

The rate of diffusion of deuterium in metals can be studied by measuring the counting rate of neutrons from the $D(d,n)He^3$ reaction occurring in metals irradiated with low energy deuteron A method of analysing the time-dependence of the observed neutro counting rate is presented and applied to experiments on Cu in the temperature range −46° to +20° C. It is concluded from the resul that grain boundary diffusion is primarily responsible for the movement of deuterium in polycrystalline Cu in this temperature range. The apparent activation energy for diffusion of deuterium polycrystalline 99.999% Cu is found to be 0.12 ± 0.02 eV/atom. Chemical purity appears to play an influential role in deuterium d fusion in Cu, the rate in OFHC Cu being significantly lower than that in the more pure material. A surface resistance effect, inde pendent of the crystallinity of the specimen but proportional to the deuteron beam current, was found to be of major importance in determining the rate of escape of deuterium from the targets.

53

13560 DIFFUSION OF Li IN Si AT HIGH T AND THE ISOTO EFFECT. E.M.Pell.

Phys. Rev., Vol. 119, No. 3, 1014-21 (Aug. 1, 1960).

The diffusion rate of Li in Si at high temperatures was re-investigated using an outdiffusion technique. The resulting D for is $(2.21 \pm 0.07) \times 10^{-6}$ cm^2/sec at (800 ± 5)°C and 2.4×10^{-5} cm^2/ at (1350 ± 5)° C. If these results are combined with ion drift resu the diffusion constant can be described by

$$D = (2.5 \pm 0.2) \times 10^{-3} \exp[-(0.655 \pm 0.01)\, e/kT].$$

The isotopic effect upon the diffusion was investigated using Li^6 a Li^7. At 800° C, the value for D_{Li^6}/D_{Li^7} is $1.07_5 \pm 0.02$, in accord with the expected inverse dependence on the square root of the m The ionic charge of the Li and the atomic mechanism for Li diffu is discussed in the light of these and other results.

539.2

3561 DIFFUSION RATE OF Li IN Si AT LOW TEMPERATURES.

E.M.Pell.

s. Rev., Vol. 119, No. 4, 1222-5 (Aug. 15, 1960).

The method of ion drift in the electric field of an n—p junction
used to measure the diffusion constant of Li in Si between 25°
125° C, taking particular care to avoid chemical and electrical
ractions which might affect the results. When these data are
ibined with previous high-temperature data, there is obtained

$$D = (2.5 \pm 0.2) \times 10^{-3} \exp[-(0.655 \pm 0.01)e/kT] \text{ cm}^2/\text{sec},$$

data extending over eight decades in D. The results are com-
ed with those from ion-pair relaxation experiments, and it is
wn that the latter are consistent with the ion-drift results.

539.2

13562 SELF-DIFFUSION OF OXYGEN IN SINGLE CRYSTAL AND POLYCRYSTALLINE ALUMINUM OXIDE.

ishi and W.D.Kingery.

hem. Phys., Vol. 33, No. 2, 480-6 (Aug., 1960).

The self-diffusion coefficient of oxygen was determined as a
ction of temperature in single crystal and polycrystalline Al_2O_3
emperatures up to 1780°C. The rate of exchange between a gas
se and solid particles was measured, utilizing the stable isotope,
. In Al_2O_3 single crystals intrinsic diffusion occurs in a high
perature region, varying as $D = 1.9 \times 10^3 \exp(-152\,000/RT)$.
temperatures below about 1600°C variable results were
ained depending on impurity content and previous heat treat-
nt. For one set of samples experimental results could be repre-
ted as $D = 6.3 \times 10^{-8} \exp(-57\,600/RT)$. The diffusion coefficient
xygen in polycrystalline samples is about two orders of magni-
e larger than that found for the single crystals, and has a some-
t smaller activation energy. With the polycrystalline oxide,
iable results were also observed at lower temperatures.

539.2

13563 THE DIFFUSION OF URANIUM INTO ALUMINUM.

T.K.Bierlein and D.R.Green.

lear Sci. Engng, Vol. 2, No. 6, 778-86 (Nov., 1957).

The maximum penetration of uranium into aluminium in the
perature range 200-390° C has been investigated. The maximum
ues for the penetration coefficient K_T, determined from the
ationship $K_T = x^2/t$, are 0.075, 0.50, and 6.1 × 10^{-6} in.^{2}/hr at
peratures of 200, 250 and 390° C, respectively; the corresponding
ivation energy is 14 300 cal/mole. The utility of cathodically
uum etching specimens to obtain clean metal surfaces prior to
diffusion anneal is demonstrated. Couples prepared in the temp-
ture range investigated, 200-390° C, fracture by the application
ension between the aluminium and the adjacent UAl_3 diffusion
e interface. Subsequent measurement of the maximum UAl_3
k heights above the initial uranium—aluminium interface assures
aximum value of the penentration coefficient. The investigation
vides a necessary basis for interpreting the effect of irradiation
the diffusion rates of uranium into aluminium.

539.2

13564 HOW FOCUSING COLLISIONS CAUSE RADIATION DAMAGE.

M.W.Thompson.

cleonics, Vol. 18, No. 6, 133, 135, 136, 139-41 (June, 1960).

The lattice structure of crystals may result in the momentum
a colliding particle being focused along a line of close-packed
ms. This results in dissipation of the energy without damage.
e effect is important in materials of medium or large atomic
ight when the interatomic distance is less than four times the
mic radius. The effect has been demonstrated in a thin radio-
tive gold foil bombarded by 300 keV protons. An autoradiograph
wed preferential ejection of Au atoms in the close-packed (110)
ections.

R.D.Smith

539.2

13565 MICROSCOPIC STUDY OF NEUTRON-IRRADIATED GERMANIUM.

3.Meckel, E.G.K.Schwartz and R.A.Swalin.

appl. Phys., Vol. 31, No. 7, 1299 (July, 1960).

Etching of the irradiated samples revealed a high density of
all etch pits of random distribution. The observed density agrees
h estimates based on a theory of displacement spikes. The
terns may be the first visual evidence of spike formation.

C.Hilsum

539.2

13566 A CHEMICAL MODEL OF RADIATION DAMAGE IN GRAPHITE.

G.R.Hennig.

Nuclear Sci. Engng, Vol. 3, No. 5, 514-28 (May, 1958).

It is shown that the production rate of electron traps during fast neutron bombardment of graphite can be determined by comparing its properties with those of chemically doped graphite. A value of 9 × 10^{-5} trap per equivalent megawatt day unit of reactor bombardment is obtained. This comparison also shows how the scattering of the carriers is affected by bombardment. The validity of the conclusions which are reached depends upon certain assumptions concerning anisotropy and heterogeneity, which are explored in rather considerable detail.

539.2

13567 INTERSTITIAL COMPOUNDS OF IRRADIATED GRAPHITE.

G.L.Montet.

Nuclear Sci. Engng, Vol. 4, No. 1, 112-33 (July, 1958).

As the result of an attempt to prepare unordered compounds of graphite containing more than 1.5 × 10^{-3} acceptor per carbon atom by the introduction of both chemical acceptors and radiation damage centres, evidence has been found for mutual destruction of chemical acceptors and damage centres. An analysis of the kinetic behaviour of the mutual destruction indicates that the extent of destruction is independent of the order in which the radiation damaging and chemical treatments are carried out. From some auxiliary experiments made necessary by the discovery of the above interaction, it is concluded that the graphite bisulphate residue compounds are stable at room temperature, and that the bisulphate ion is not appreciably decomposed by the gamma flux in the reactor during short irradiations. The dependence of some electrical properties of graphite on the concentrations of both chemical acceptors and radiation damage centres has been analysed on the basis of the two-band theory of a semiconductor above its degeneracy temperature. It is concluded that, whereas the Hall effect may be reasonably well understood, the behaviour of the electrical resistance and magnetoresistance cannot be understood in terms of this theory, so that the introduction of additional hypotheses appears necessary.

539.2

13568 ELECTRON DAMAGE IN MICA.

T.J.Seed.

J. appl. Phys., Vol. 31, No. 7, 1300 (July, 1960).

Reports irradiation damage to a mica crystal in a soft X-ray spectrograph. The damage took the form of undulating lines spaced 41 microns apart. The cause of the damage was not ascertained.

T.Mulvey

539.2

13569 RADIATION EFFECTS OF BOMBARDMENT OF QUARTZ AND VITREOUS SILICA BY 7.5 keV TO 59 keV POSITIVE IONS.

R.L.Hines and R.Arndt.

Phys. Rev., Vol. 119, No. 2, 623-32 (July 15, 1960).

Bombardment of quartz or vitreous silica by positive ions produces a surface layer of altered refractive index whose depth and refractive index is found from reflection coefficient measurements at 650, 600, 550, 500 and 450 mμ. The layer depths and the changes in refractive index versus integrated flux are given for H_2^+, D_2^+, He^+, Ne^+, A^+, Kr^+, and Xe^+ ions with energies from 7.5 to 59 keV. All bombardments give approximately equal changes in refractive index for a given energy input per unit volume of material as long as the ion energy is low enough so that energy loss by ionization is negligible. The changes produced by ion bombardment are attributed to direct lattice displacements and are shown to be consistent with the known changes produced in quartz and vitreous silica by fast neutron bombardment. Thermal spikes produced by knock-on atoms in quartz and vitreous silica are experimentally shown to be unimportant for knock-on energies near 45 keV.

539.2

13570 THERMAL CYCLING OF α-URANIUM.

H.Bairiot.

Rev. Soc. Roy. Belge Ingen. Industr., 1960, No. 3, 101-26 (March). In French.

Thermocycling damage to uranium is described with reference to earlier work. Two earlier theoretical approaches (thermal ratcheting and "creep" mechanism) are shown to be inadequate. It was observed microscopically that the growth was concentrated in those grains in which the [010] axis is near the growth direction of the specimen. A theory, based upon those observations and the fact that dislocation flow may be initiated by moving twin planes, leads to

$$Gt = (\alpha_{(010)} - \alpha_{[010]})(T_h - T_c)\,PS$$

Such a formula might explain all observed phenomena. Interesting conclusions are drawn concerning the choice of a fuel and its working conditions.

539.2

13571 RADIATION DAMAGE IN ORGANIC CRYSTALS. I. $CH(COOH)_2$ IN MALONIC ACID.

H.M.McConnell, C.Heller, T.Cole and R.W.Fessenden.
J. Amer. Chem. Soc., Vol. 82, No. 4, 766-75 (Feb. 20, 1960).

An analysis of the electron magnetic resonance of single crystals of malonic acid that were subjected to X-ray damage indicates that: (1) the principal long-lived paramagnetic species produced by the X-ray damage is $CH(COOH)_2$. (b) The carbon, oxygen and carboxyl hydrogen atoms of this radical are oriented in the crystalline lattice in the same way as these atoms are arranged in the parent undamaged malonic acid molecule. (c) The z,x,y components of the diagonal (electron-spin)–(nuclear-spin) coupling dyadic for the proton attached to the α-carbon atom are found to be of the same relative sign and of magnitudes 29, 61 and 91 Mc/s, respectively. In this orthogonal axis system, z is the CH bond direction and x is perpendicular to the plane of the three carbon atoms. These results are in excellent agreement with theoretical values of the distributed dipole and contact hyperfine interactions and show that this molecule is a π-electron radical, that the unpaired electron is concentrated almost entirely on the α-carbon and that the spin density on the in-plane σ-proton is negative. The observed g-factors for this radical are $g_x = 2.0026$, $g_y = 2.0035$ and $g_z = 2.0033$ and are in good qualitative agreement with previous theoretical estimates of these quantities.

539.2

13572 RADIATION DAMAGE IN ORGANIC CRYSTALS. II. ELECTRON SPIN RESONANCE OF $(CO_2H)CH_2CH(CO_2H)$ IN β-SUCCINIC ACID.

C.Heller and H.M.McConnell.
J. chem. Phys., Vol. 32, No. 5, 1535-9 (May, 1960).

An analysis of the electron spin resonance of X-irradiated single crystals of β-succinic acid shows that: (1) the principal long-lived paramagnetic species produced by the radiation damage is $(CO_2H)CH_2–CH(CO_2H)$; (b) the radical is oriented in the crystal lattice in nearly the same way that the parent succinic acid molecule is oriented in the undamaged lattice; (c) the strongly anisotropic hyperfine interaction due to the σ proton is very nearly the same as that previously found for the σ proton in the malonic acid radical, $(CO_2H)CH(CO_2H)$. In these molecules the σ proton is directly bonded to the carbon atom on which the odd electron is largely localized. The two methylene protons in the radical are not equivalent, and their hyperfine interactions are nearly isotropic, and in the range 80-100 Mc/s.

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

539.2 : 537.3

13573 THE SOLUTION OF THE BOLTZMANN EQUATION BY ASSUMING A CONSTANT RELAXATION TIME.

Z. Bodó.
Acta phys. Hungar., Vol. 8, No. 1-2, 177-9 (1957).

An exact solution of the Boltzmann equation is given for electrons having the Maxwell–Boltzmann distribution in a homogeneous electrical field and assuming a constant relaxation time. Ohm's law and Joule's law can be immediately obtained from the solution.

539.2 : 537.3

13574 AN ANALOGY BETWEEN THE EFFECTS OF FLUCTUATING ELECTRIC FIELDS AND STEADY MAGNETIC FIELDS IN ISOTROPIC CONDUCTORS WHEN A UNIVERSAL RELAXATION TIME CANNOT BE DEFINED.

E.J.Moore.
Austral. J. Phys., Vol. 13, No. 1, 95-7 (March, 1960).

It is shown that for an electric field of frequency $\omega/2\pi$ and a steady magnetic field H, the solutions of the Boltzmann equation for the three field combinations $(\omega \neq 0, H = 0)$, $(\omega = 0, H \neq 0)$, and $(\omega \neq 0, H \neq 0)$ are essentially the same. D.M.Edwards

539.2 : 53

13575 ELECTRON SCATTERING IN HIGH MAGNETIC FIEL

A.H.Kahn.
Phys. Rev., Vol. 119, No. 4, 1189-92 (Aug. 15, 1960).

Electrical conductivity in a strong magnetic field is calculate for the case of scattering by delta-function impurities. The impu concentration is taken as sufficiently weak that collision broadeni may be neglected. The scattering by an individual centre is solve exactly rather than by perturbation theory. As a result, transitio probabilities for an electron at the bottom of a Landau level vanis rather than diverge. Expressions are given for the longitudinal a transverse conductivities in the oscillatory range, and in the quan limit range for degenerate and nondegenerate statistics. The rela tion of this theory to those employing collision broadening is discussed.

539.2 : 5

13576 ON THE THEORY OF THE SKIN EFFECT IN A TRANSITION REGION.

V.I.Volosov and B.V.Chiriko
Zh. tekh. Fiz., Vol. 30, No. 5, 508-11 (May, 1960). In Russian.

A time-periodic magnetic field outside a semi-infinite metal medium penetrates it in a transition region. The field expressio is obtained by means of the convolution integral and approximate by a closed formula under carefully stated conditions. J.K.Skwirzyn

539.2 : 5

13577 THE NATURE OF THE ELECTRICAL CONDUCTION SOME TRANSITION-METAL COMPOUNDS WITH TH $CuAl_2$-TYPE LATTICE.

L.D.Dudkin and V.I.Vaidanich.
Fiz. tverdogo Tela, Vol. 2, No. 3, 404-5 (March, 1960). In Russia

Measurements of the electrical conductivity and thermoelect power of $MnSn_2$, $FeSn_2$, $CoSn_2$, $TiSb_2$ and VSb_2 confirmed the theo cal prediction (from overlapping of the d-electron wave-functions of the metallic nature of their conduction. A.Tybulew

539.2 : 53

13578 SOME PECULIARITIES OF THE ELECTRICAL CON TIVITY OF GUANIDINE ALUMINUM SULPHATE HE HYDRATE (GASH).

V.M.Gurevich, I.S.Zheludev and I.S.Rez.
Kristallografiya, Vol. 4, No. 5, 718-22 (Sept.-Oct., 1959). In Rus English translation in: Soviet Physics–Crystallography (New Yor Vol. 4, No. 5, 679-82 (May, 1960).

A d.c. method of measuring the electrical conductivity of sin crystals of GASH is described and the results of measurements a given. The existence of transitional conductivity processes and a anomaly in the region of +50° C were found.

539.2 : 537.3 : 5

RESISTIVITY OF SOLID AND LIQUID GALLIUM. See Abstr. 12419

539.2 : 537.3 : 537.

13579 TRANSFER OF ELECTRIC CHARGES THROUGH RU SINGLE CRYSTALS.

K.G.Srivastava.
Phys. Rev., Vol. 119, No. 2, 520-4 (July 15, 1960).

Electron transfer and onset of field emission were investiga in TiO_2 single crystals with d.c. current-time characteristics pa llel and perpendicular to the optic axis as function of voltage, te ture, electrode material, and light absorption. The currents are much larger and field emission sets in at lower voltage when the field is parallel to the optic axis. Higher temperature favours th current transfer by increasing the carrier mobility. The effect c different electrode materials proved minor, except in the case of Ti, which as cathode raised the current by about one order of ma tude. Photoelectric measurements showed that, in the critical voltage region of incipient field emission, light absorption can apparently force the current reversibly into the field-emitting s

539.2 : 53

13580 HALL COEFFICIENT IN TIN–BISMUTH ALLOYS.

P.A.Bender and W.F.Love.
Phys. Rev., Vol. 119, No. 2, 506-7 (July 15, 1960).

The Hall coefficient in a series of tin–bismuth alloys was measured at 75° K as a function of composition. The results are compared with previous results on the band structure in these al They indicate that hole conduction is present though not always d nant throughout the range of alloys studied.

539.2 : 537.3

13581 GALVANOMAGNETIC AND THERMOMAGNETIC POTENTIALS IN ZINC AT LIQUID HELIUM

MPERATURES. C.J.Bergeron, C.G.Grenier and J.M.Reynolds.
s. Rev., Vol. 119, No. 3, 925-34 (Aug. 1, 1960).

The Hall effect, magnetoresistance, thermoelectric voltage, and
isverse Ettingshausen—Nernst potential were measured in a single
stal of zinc in the liquid helium temperature range. Oscillations
function of magnetic field strength were observed in all of these
ntials. The measured period in 1/H for the transverse oscilla-
s was 6.2×10^{-6} G^{-1} ± 0.5%, with the magnetic field parallel to
hexagonal axis. Both transverse effects possessed strong second
monic oscillations. The oscillations in the longitudinal effects
exhibited a phase inversion in the neighbourhood of 4.2 kG, the
e field region for which the gross Hall field changed sign. In
same field region the period of the oscillations for the longi-
nal effects was that of the second harmonic. Empirical correla-
s between the reversal of sign of the Hall effect and: (1) the phase
ersal of the magnetoresistance oscillations, (2) the strong second-
monic content of these oscillations in the region of the phase re-
sal, and (3) the quadratic shape of the envelope of the magneto-
stance oscillations in this region can be achieved by assuming
oscillatory component of σ_{21} to be much more significant than
of σ_{11}, where σ_{ik} is the conductivity tensor. A further correla-
between the oscillatory thermal effects can be achieved by
ming that the difference of the absolute thermoelectric power-
the temperature derivative of the chemical potential is negligible.

539.2 : 537.3

13582 EFFECT OF UNIFORM COMPRESSION ON THE ETTINGSHAUSEN—NERNST EFFECT IN ZINC AT LOW

MPERATURES. K.S.Balain, C.G.Grenier and J.M.Reynolds.
s. Rev., Vol. 119, No. 3, 935-8 (Aug. 1, 1960).

The influence of hydrostatic pressure on the oscillatory
ngshausen—Nernst effect in a zinc single crystal was studied in
netic fields ranging from 2 to 11 kG at 4.2°K. With the field
g the hexagonal axis, the long period oscillations decrease in
iod by 5% as the pressure is increased from 300 to 2300 lb/in.^{2}.
re is an average increase in amplitude of about 10% for each
lb/in.^{2} increase of pressure. There is no evidence of phase
nge with pressure.

539.2 : 537.3

13583 THE ANISOTROPY IN THE MAGNETO-RESISTANCE OF SOME NICKEL ALLOYS. H.C.Van Elst.

sica, Vol. 25, No. 8, 708-20 (Aug., 1959).

Measurements are reported of the anisotropy of the magneto-
istance of about 40 alloys in external magnetic fields at room,
id nitrogen and liquid hydrogen temperatures. The results are
cussed in the light of different theoretical models. It is suggested
the density of energy states at the surface of the Fermi distri-
ion of electrons in an essential factor.

iconductors

539.2 : 537.311

3584 EFFECT OF ELECTRON—ELECTRON SCATTERING ON HALL MOBILITY OF ELECTRONS IN N[-TYPE]

ICONDUCTORS. M.S.Sodha and P.C.Eastman.
gr. theor. Phys., Vol. 19, No. 3, 344-6 (March, 1958).

The simple theory of impurity scattering predicts a ratio 1.93
all to drift mobility. The authors show how, by using a theory
ch takes into account electron—electron as well as electron—ion
raction, a ratio of 1.18 can be derived, in much closer agree-
t with experiment. K.W.Plessner

539.2 : 537.311

13585 DETERMINATION OF NUMBERS OF INJECTED HOLES AND ELECTRONS IN SEMICONDUCTORS.

an der Maesen.
lips Res. Rep., Vol. 15, No. 2, 107-19 (April, 1960).

In semiconductors, deviations Δn and Δp of the equilibrium
bers n_0 and p_0 of electrons and holes are unequal in many cases
ause of trapping. It is shown how measurements of the photo
l-effect and photoconduction may give information on the numbers
and Δp separately. From the ratio Y of the relative change of
Hall effect and of the photoconductivity, the quantity K = Δn/Δp
be evaluated. Graphs of Y versus K for some substances are given. It is shown how K occurs in the formulae used in computations of the diffusion-recombination length L from photoelectromagnetic and photoconductive data. If r_n and r_p denote the ratios of of the Hall mobility to drift mobility for electrons and holes, respectively, r_n/r_p can be evaluated from the measurements where K = 1. In this way the value of r_n/r_p at room temperature is found to be 0.54 ± 0.05 for germanium and 0.78 ± 0.04 for silicon.

539.2 : 537.311

13586 CURRENT-CARRIER TRANSPORT AND PHOTOCONDUCTIVITY IN SEMICONDUCTORS WITH TRAPPING.

W.van Roosbroeck.
Phys. Rev,, Vol. 119, No. 2, 636-52 (July 15, 1960).

Fundamental differential equations are derived under the unrestricted approximation of electrical neutrality that admits trapping. Applied magnetic field is taken into account. The general transport equations derived hold without explicit reference to detailed trapping and recombination statistics. Modified ambipolar diffusivity, drift velocity, and lifetime function, which depend on two phenomenological differential "trapping ratios", apply in the steady state. The same diffusion length is shown to hold for both carriers, and a general "diffusion-length lifetime" is defined. Mass-action statistics are considered for cases of (one or) two energy levels. Certain "effective"—rather than physically proper—electron and hole capture and release frequencies or times that apply to concentration increments are defined, and a restriction from detailed balance to which they are subject is derived. Found widely useful is "capture concentration", the concentration of centres at equilibrium that are occupied times the fraction unoccupied. Criteria are given for minority-carrier trapping, recombination, and majority-carrier trapping, and for "shallow" and "deep" traps. Applications of the formulation include: the diffusion-length lifetime corresponding to the Shockley—Read electron and hole lifetimes, and that for recombination centres in the presence of (nonrecombinative) traps; linear and nonlinear steady-state and transient photoconductivity; the photomagnetoelectric effect; and drift of an injected pulse. The small- and large-signal nonlinearities that may occur with saturation of deep traps provide a single-level model for superlinearity. Photomagnetoelectric current is found to be decreased by minority-carrier trapping, through an increase in diffusion length. A simple general criterion is given for the local direction of drift of a concentration disturbance. With trapping, there may be "reverse drift", whose direction is normally that for the opposite conductivity type. With solutions of one type obtained for drift of an injected pulse, multiple trapping ultimately results in Gaussian mobile-carrier distributions which spread as if through diffusion and which drift at a fraction of the ambipolar velocity. With solutions of another type, related to reverse drift is the occurrence of local regions of mobile-carrier depletion which may in practice extend over appreciable distances. [For a more detailed and extended treatment with further applications, see W. van Roosbroeck, Bell Syst. tech. J., Vol. 39, 515 (1960)].

539.2 : 537.311

13587 DETERMINATION OF THE CARRIER MOBILITY AND DENSITY IN THE SURFACE LAYER OF A SEMICONDUCTOR.

V.K.Subashiev and S.A.Poltinnikov.
Fiz. tverdogo Tela, Vol. 2, No. 6, 1169-77 (June, 1960). In Russian.

Describes a method of determination of the carrier density and mobility in a layer produced by diffusion of an impurity from the surface of a semiconductor. The method is based on measurement of the electrical conductivity and the Hall constant, and it is applied to silicon photocells. A.Tybulewicz

539.2 : 537.311 : 621.382

13588 STUDY OF CHARGE CARRIERS IN SEMICONDUCTORS SUBJECTED TO AN INTENSE ELECTRIC FIELD.

J.Bok.
Ann. Radioelect., Vol. 15, 120-46 (April, 1960).

Examines the behaviour of a semiconductor subjected to an intense electric field. A method of calculation is given, valid in the case of a large number of carriers, which makes it possible to calculate electron temperature and current as a function of applied electric field when the nature of the collisions of these electrons is known. This method is then applied to a number of cases and its validity is verified by experimental results. It is then shown how the electron temperature can have an influence on other secondary physical phenomena: generation of new carriers by shock, thermoelectric effects due to hot electrons and emission of electrons out of the crystal.

539.2 : 537.311

13589 MEASUREMENT OF DECAY TIMES OF EXCESS CARRIERS IN SEMICONDUCTORS, EXCITED BY X-RAY PULSES. J.A.W. van der Does de Bye.

Philips Res. Rep., Vol. 15, No. 3, 275-89 (June, 1960).

A method for the measurement of transient decay times of excess carrier concentrations in homogeneous semiconductors is described. The exciting agent is X-rays, which are delivered in short pulses of 0.1-0.3 µsec. A reasonable excitation (about 10^{12} cm^{-3} per pulse in Ge) requires peak currents of several tens of amperes through the X-ray tube, which is fitted with a large dispenser cathode. Two pulse generators, which can deliver the short, high-tension pulses of 80 kV and of 150 kV, are used. These two voltages imply two different effective linear X-ray attenuation coefficients for every substance. For germanium they are about 20 cm^{-1} and 8 cm^{-1}. This affords a reasonable possibility of exciting the bulk without much disturbance by surface recombination. Excitation, dissipation, sample geometry and noise set a minimum to the resistivity of the sample for the production of a clearly visible decay curve on the oscilloscope. For Ge this is between 0.1 and 1 ohm cm. The measuring apparatus comprises an exponential time base and a decay-curve simulator for the measurements of decay time constants, down to 0.1 µsec. Measurements performed on copper-doped germanium yield decay times which are also found with chopped light. Some measurements on CdTe are also described.

539.2 : 537.311

13590 ON THE RECOMBINATION PROCESSES BY THE AUGER EFFECT. M.Nagae.

Prog. theor. Phys., Vol. 19, No. 3, 339-40 (March, 1958).

Brief calculations are presented concerning the probability of an electron being trapped from the conduction band by Auger effect. It is concluded that the Auger effect can be neglected compared with multiphonon processes in the case of ordinary recombination processes. See also following abstract. P.T.Landsberg

539.2 : 537.311

13591 ON THE AUGER EFFECT IN THE DEEP TRAPS IN Si. M.Nagae.

Progr. theor. Phys., Vol. 19, No. 3, 341-2 (March, 1958).

It is suggested that in these cases the Auger effect is important, and calculations given in the preceding paper are used to establish this point quantitatively. P.T.Landsberg

539.2 : 537.311

13592 THE DETERMINATION OF THE PHYSICAL PARAMETERS OF THE RECOMBINATION CENTRES PRODUCED BY COPPER IN GERMANIUM.

M.I.Iglitsÿn and Yu.A.Kontsevoi.

Fiz. tverdogo Tela, Vol. 2, No. 6, 1148-51 (June, 1960). In Russian.

The lifetime of minority carriers is determined at low and high levels of injection, giving τ_0 and τ_∞. Results are given as function of 1/T for electron and hole conductivity. The appropriate formulae are given and the following deductions made: (1) at 200° K the ratio of the total capture cross-sections of level 2 for electrons to that of level 3 for holes $C_{n2}/C_{p3} = 0.155$; (2) at low temperatures C_{p3} is independent of temperature, while C_{n2} increases with decreasing temperature exponentially, with an activation energy 0.045 ± 0.005 eV. By extrapolation, the above ratio becomes 0.07 at 300° K; (3) $E_2 - E_V = 0.32 \pm 0.02$ eV, $E_C - E_3 = 0.22 \pm 0.02$ eV, assuming that $C_{p3}/C_{p2} = 24$ and is independent of temperature; (4) absolute cross-sections at 300° K are $\alpha_{p3} = 1.8 \times 10^{-16}$ cm^2, $\alpha_{n2} = 1.3 \times 10^{-17}$ cm^2. R.Berman

539.2 : 537.311 : 541.13

13593 LOCATION OF DIFFUSED P—N JUNCTIONS ON GERMANIUM BY ELECTRODEPOSITION OF COPPER. R.Glang.

J. Electrochem. Soc., Vol. 107, No. 4, 356-7 (April, 1960).

Describes a technique for delineating the junction between p-type Ge and a thin n-type diffused layer. The junction is exposed on a bevelled face and plated from a small drop of plating solution [20 g $CuSO_4.5H_2O$ in 80 ml H_2O plus 1 ml HF (49%)] using a pulsed d.c. voltage under stringent conditions. W.Bardsley

539.2 : 537.311

13594 GERMANIUM P—N JUNCTIONS PLASTICLY DEFORMED. M.Bernard and B.Leduc.

J. Phys. Chem. Solids, Vol. 13, No. 1-2, 168-9 (May, 1960). In French.

Reverse characteristics of p—n junctions in almost dislocation free germanium are contrasted with those when the crystal has been plastically deformed. A marked softening of the characteristics found and this was attributed to the presence of large numbers of dislocations. These were thought to aid the Zener breakdown by giving rise to locally enhanced electric fields. W.G.Towns

539.2 : 537.

13595 IMPURITY CONDUCTION IN TRANSMUTATION-DOPED p-TYPE GERMANIUM. H.Fritzsche and M.C

Phys. Rev., Vol. 119, No. 4, 1238-45 (Aug. 15, 1960).

The Hall coefficient and resistivity of germanium single crys bombarded with slow neutrons were measured between 1.2° and 300° K. Slow neutron capture and subsequent nuclear transmutati produce majority impurities, gallium atoms, and compensating impurities, arsenic and selenium atoms. p-type samples with a gallium concentration ranging from 8×10^{14} to 5×10^{7} per cm^3 wi a fixed compensation ratio of 0.40 were thus prepared and the impurity conduction was studied as a function of the average distanc between the majority impurities. The effective radius a of the acceptor ground-state wave-function is 90.1 A according to Mille theory of impurity conduction, whereas a = 40 A according to Tw theory. The latter value agrees well with the effective radius of Kohn—Schechter acceptor wave-function. The activation energy impurity conduction changes slowly with impurity concentration from 3.5×10^{-4} to 5.9×10^{-4} eV and agrees well with the predictions of Miller's theory for gallium concentration below 5 × 10 cm^3. Measurements on samples which contain different dislocati densities but identical impurity concentrations show that up to 10 dislocations per cm^2 do not affect impurity conduction.

539.2 : 537.

13596 THE INFLUENCE OF DEFORMATION ON THE ELECTRICAL PROPERTIES OF P-TYPE GERMANI AND SILICON. G.E.Pikus and G.L.Bir.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1828-40 (Dec., 1959). In Russ

See also Abstr. 7945 of 1958. The expression for the energy spectrum of holes in a deformed lattice of the germanium type derived earlier by the authors (Abstr. 11694 of 1960) is used to calculate the change of conductivity, Hall constant and magnetore tance produced by a uniform deformation. R.B.Stinchcom

539.2 : 537.

13597 TRANSITORY ELECTRICAL PROPERTIES OF n—T GERMANIUM AFTER A NEUTRON PULSE. H.J.Stei

J. appl. Phys., Vol. 31, No. 8, 1309-13 (Aug., 1960).

The stability of neutron bombardment damage in Sb doped G has been investigated by making continuous measurements of the electrical conductivity and Hall mobility following a neutron puls Measurements were made in the temperature range from 77° to 3 with a time resolution of 1 sec. At temperatures near 195° K an i decrease in conductivity and mobility was followed by an addition decrease which exhibited nearly second-order kinetics. At 273° and above, an initial decrease in conductivity and mobility was ob served, but was followed by a recovery consistent with an activat energy of 0.68 eV. The void region model of Gossick (Abstr. 110 of 1959) and Crawford (Abstr. 11008 of 1959) has been employed explain the initial decrease in mobility and a major portion of the initial decrease in conductivity. The transitory changes in mobil and conductivity after the neutron pulse are considered as change the void volumes.

539.2 : 537

13598 MOBILITY IN HIGH-RESISTIVITY GERMANIUM AT HIGH D.C. ELECTRIC FIELDS. J.Zucker.

J. Phys. Chem. Solids, Vol. 12, No. 3-4 350-2 (Feb., 1960).

The conductivity of thin filaments attached to massive cryst of Ge was measured up to fields of 3×10^4 V/cm, using 3 µs pulse The results, which are in agreement with some of the previous work, are plotted in detail. Roughly, σ decreases as 1/E in the region of E = 10^4 V/cm. K.W.Pless

539.2 : 537.

13599 ON THE MAGNETORESISTANCE OF GERMANIUM. A.Lőrinczy and P.Szebeni.

Acta phys. Hungar., Vol. 11, No. 2, 209-11 (1960). In German.

Describes the measurement technique and the results for magnetoresistance as a function of magnetic induction for speci very highly doped with Cu, Sb, In respectively. C.A.Hoga

539.2 : 537.311

600 AUGER ELECTRON EJECTION FROM GERMANIUM AND SILICON BY NOBLE GAS IONS.

H.D.Hagstrum.
. Rev., Vol. 119, No. 3, 940-52 (Aug. 1, 1960).

Reports results on electron ejection from annealed, atomically surfaces of germanium and silicon by the singly charged ions e noble gases. The (111) and (100) faces of silicon and the (111) of germanium were studied. Total yield and kinetic energy distion of ejected electrons were measured for ion energies in the e 10 to 1000 eV. A new method of operation of the apparatus and taining the kinetic energy distributions from the recorded reng potential data was employed. Details of the state of the tarurfaces is given including photomicrographs and electron microns of the silicon surfaces. Since these experimental results are equently to be interpreted theoretically, identification of the re- with the theoretical ideas only is given here.

539.2 : 537.311

3601 EFFECT OF CHEMICAL ETCHES ON THE FAST GERMANIUM SURFACE STATES.

Y.Margoninski.
em. Phys., Vol. 32, No. 6, 1791-5 (June, 1960).

Simultaneous measurements of surface recombination velocity dded trapped charge density in the fast states as a function of surface ntial were carried out on one and the same n-type filament which subjected to three different etches: CP-4A, concentrated HNO_3 HF. Most measurements were performed at various tempera-. It was found that (a) reproducibility of surface state parars after successive treatments with CP-4A was excellent; he influence of the different etches was surprisingly small, one exception: the average capture probability c_p for holes found to undergo a more than threefold increase after treatment HF; (c) the energy of the recombination centre did not always ease with increasing temperature, contrary to all previously rted measurements.

539.2 : 537.311 : 669

THE REMOVAL OF NICKEL FROM GERMANIUM.

Abstr. 12231

539.2 : 537.311

3602 TRANSMITTED PHONON DRAG MEASUREMENTS IN SILICON.

K.Hubner and W.Shockley.
. Rev. Letters, Vol. 4, No. 10, 504-5 (May 15, 1960).

In a n—p—n sandwich, square waves are applied to the top yer producing an input field E_1 between voltage probes. In ssociated energy flow due to phonon drag, the phonons move in irections. Some reach the bottom n-layer to produce a transed drag upon the electrons and set up an open circuit output E_2 of opposite polarity to E_1. An expression is given for the E_2/E_1. The exponential decrease of this ratio with increasing ness of the intermediate p-layer was verified experimentally. riety of possible experiments using this transmitted phonon effect is suggested. L.Pincherle

539.2 : 537.311

603 THE EFFECT OF HEAT TREATMENTS ON THE ELECTRICAL PROPERTIES OF P-TYPE SILICON.

Kirvalidze and V.F.Zhukov.
tverdogo Tela, Vol. 2, No. 4, 571-4 (April, 1960). In Russian.

The electrical resistivity (ρ) of p-type silicon monocrystals sharply and the carrier density (N) fell when the samples were ed to 800°C and quenched in oil at 50°C. The new values of ρ N were unstable and the original values were recovered after ours at room temperature or 1 hour at 100°C. Heating of the ples for 8 hours at 1200°C reduced the effect of subsequent C heating and quenching, and slowed down the eventual recovery e initial resistivity. A.Tybulewicz

539.2 : 537.311

3604 INVESTIGATION OF THE SEMICONDUCTING PROPERTIES IN THE SILICON—COBALT SYSTEM.

Nikitin.
tverdogo Tela, Vol. 2, No. 4, 633-6 (April, 1960). In Russian

The variation of both the electrical conductivity and thermoric effect in the silicon—cobalt system as a function of position was investigated. The temperature dependence of these tities in CoSi was observed, and also for compositions slightly ch side of the stoichiometric one. K.N.R.Taylor

539.2 : 537.311 : 537.533

PHOTOEMISSION FROM SI INDUCED BY AN INTERNAL CTRIC FIELD.

See Abstr. 12627

539.2 : 537.311

13605 BRILLOUIN ZONES, CHEMICAL BONDS AND CONDUCTION MECHANISM IN Ag_2S AND Ag_2Se.

G.Busch and P.Junod.
Helv. phys. Acta, Vol. 32, No. 6-7, 601-14 (1959). In French.

For the electronic properties of these compounds see Abstr. 7946 of 1960. The zones are described for the metallic face-centred cubic α-phase, as well as for the tetragonal semiconducting β-phase. The possible positions in k-space of the pockets of holes and electrons are discussed. There are three atomic configurations compatible with the zone scheme, but with different types of chemical bonds. L.Pincherle

539.2 : 537.311

13606 DEVICE FOR MEASUREMENT OF THE ELECTRICAL PROPERTIES OF Bi_2Se_3 AT ELEVATED TEMPERATURES.

M.J.Smith, E.S.Kirk and C.W.Spencer.
J. appl. Phys., Vol. 31, No. 8, 1504-5 (Aug., 1960).

The construction of the apparatus is described for measurements up to about 600°C in an atmosphere of Bi_2Se_3 or Bi_2Se_3—Se mixture. Conductivity and Hall effect measurements gave an energy gap for Bi_2Se_3 of 0.36 eV, and electron mobilities of 2600 and 1600 $cm^2 V^{-1} sec^{-1}$ for a specimen containing 4×10^{17} and 5×10^{17} electrons/cm^3, respectively, at $-80°$ and 25°C. J.Franks

539.2 : 537.311

13607 CONDUCTIVITY AND STRUCTURE OF Bi_2Te_3.

O.P.Manley.
J. Phys. Chem. Solids, Vol. 11, No. 3-4, 341-2 (Oct., 1959).

A brief discussion of the types of donor and acceptor states to be expected in this compound on the basis of a model of its chemical bonding proposed by Drabble and Goodman (Abstr. 3461 of 1959). K.W.Plessner

539.2 : 537.311 : 621.382.032.27

13608 CURRENT NOISE DUE TO OHMIC CONTACTS ON CADMIUM SULFIDE.

J.Brophy and R.J.Robinson.
J. appl. Phys., Vol. 31, No. 8, 1343-4 (Aug., 1960).

Current noise measurements on the same lightly doped calcium sulphide crystal having indium soldered contacts of different quality are used to demonstrate the strong influence of contacts on the observed noise spectra. The results suggest the presence of shallow trapping states distributed in energy and located near the electrodes. The concentration of these states depends on the quality of the contact. These effects are not contact noise in the usual sense since the shape of the noise spectra is only moderately affected; however, the noise level may change by orders of magnitude.

539.2 : 537.311 : 539.213

GLASSY SEMICONDUCTORS. VII. VISCOSITY OF VITREOUS SEMICONDUCTORS IN THE As_2Se_3—As_2Te_3 SYSTEM.

See Abstr. 12062

539.2 : 537.311 : 539.2 : 535

13609 VITREOUS SEMICONDUCTORS. VIII. OPTICAL PROPERTIES OF GLASSES BASED ON THE CHALCOGENIDES OF THALLIUM, ARSENIC AND ANTIMONY.

B.T.Kolomiets and B.V.Pavlov.
Fiz. tverdogo Tela, Vol. 2, No. 4, 637-43 (April, 1960). In Russian.

For Pt VII see Abstr. 12062 of 1960. Optical absorption spectra were studied between 0.5 and 18 μ for various compositions in the systems: As_2S_3—As_2Se_3, As_2S_3—As_2Te_3, As_2Se_3--As_2Te_3, As_2Se_3--Tl_2Se, As_2S_3--Tl_2S, and As_2S_3--Sb_2S_3. Two more complex compositions: $Tl_2(Te_{0.5}Se_{0.5}).As_2Te_3$ and $Tl_2Se.3Tl_2Te.As_2Se_3.3As_2Te_3$, with main absorption edges, λ_G, at 2.07 and 3.50 μ respectively, were also studied. Optical absorption beyond the main edge was low for most glasses studied (0.5-1.0 cm^{-1}), and it is suggested that optical filters for the range 0.6-3.0 μ could be made by combining glasses with appropriate λ_G. Plots of numerous absorption spectra are presented. It is noted that polished sections cut from ingots and hot pressed discs gave almost identical plots. C.H.L.Goodman

539.2 : 537.311 : 539.213

13610 VITREOUS SEMICONDUCTORS. IX. VITRIFICATION IN COMPLEX CHALCOGENIDES BASED ON As_2S_3 AND As_2Se_3.

N.A.Goryunova, B.T.Kolomiets and V.P.Shilo.
Fiz. tverdogo Tela, Vol. 2, No. 2, 280-3 (Feb., 1960). In Russian.

For Pt VIII see previous abstract. Alloys of As_2S_3 and As_2Se_3 with the sulphides (or selenides) of elements of the groups Ib (Cu, Ag, Au), IIb (Zn, Cd, Hg), IIIb (Ga, In, Tl) and IVb (Ge, Sn, Pb) were prepared and the extent of vitrification in each ternary system was approximately determined. Tl and Ge showed a much larger vitrification than other elements. The results cannot be easily interpreted, but some correlation was found to exist between the heat of formation of the chalcogenides of the elements of groups I-IVb and the area of the vitrification zone. F.Lachman

539.2 : 537.311

13611 HEAT TREATMENT OF GALLIUM ARSENIDE.
J.T.Edmond.

J. appl. Phys., Vol. 31, No. 8, 1428-30 (Aug., 1960).

Specimens of n–type GaAs were found to become p–type or less strongly n–type as a result of heat treatment. The heat treatment was carried out in small quartz tubes, of two grades of purity. The magnitude of the changes was much less in high purity quartz. The effect in ordinary quartz was shown to be due in part to copper contamination, the copper originating in the quartz; the changes could be reduced by annealing.

539.2 : 537.311

13612 THE SCATTERING OF CURRENT CARRIERS IN GALLIUM ARSENIDE WITH STRONG DEGENERACY.
O.V.Emel'yanenko, T.S.Lagunova and D.N.Nasledov.

Fiz. tverdovo Tela, Vol. 2, No. 2, 192-7 (Feb., 1960). In Russian.

Electrical conductivity and Hall effect were measured in n- and p-type degenerate GaAs. Both mobilities were found to decrease slightly with increasing impurity concentration, to be independent of temperature at low temperatures and to decrease with increasing temperature above $\sim 100^{\circ}$K; the latter decrease is found to start at lower temperatures the stronger the degeneracy. Good numerical agreement is found with theory for the concentration dependence of the mobility and the other results are explained qualitatively assuming impurity and phonon scattering to be dominant at low and high temperatures respectively. D.J.Huntley

539.2 : 537.311

13613 HEAT TREATMENT EFFECTS IN InAs.
J.T.Edmond and C.Hilsum.

J. appl. Phys., Vol. 31, No. 7, 1300-1 (July, 1960).

Heat treatment of InAs in a silica container causes a permanent change which reduces the electron concentration, and a temporary change which increases the electron concentration. The temporary change is due to copper contamination from the container. Copper is a rapidly diffusing donor impurity in InAs, and it has a tendency to migrate to sites where it becomes electrically inactive. C.Hilsum

539.2 : 537.311

13614 PROPERTIES OF THE SEMICONDUCTOR InSb.
M.Rodot.

J. Phys. Radium, Vol. 19, No. 2, 140-50 (Feb., 1958). In French.

Review, with particular reference to the exact value of the electron effective mass and the mechanism of scattering of the electrons. The theory of the thermoelectric and thermomagnetic effects in InSb is given and experimental results are presented which support the idea that scattering by the optical lattice vibrations is the predominant mechanism.

539.2 : 537.311

13615 THE INFLUENCE OF OMNIDIRECTIONAL PRESSURE ON THE ELECTRICAL RESISTANCE AND THERMOELECTRIC POWER OF In_2Te_3.
A.A.Averkin, V.M.Sergeeva and A.I.Shelÿkh.

Fiz. tverdogo Tela, Vol. 2, No. 2, 347-9 (Feb., 1960). In Russian.

Measurements were carried out on intrinsic and on impurity n- and p-type specimens up to 7000 kg/cm^2 between 20 and 60°C. The conductivity σ of intrinsic specimens goes through a minimum, the pressure of which increases with temperature. Below $P\sigma_{min}$ the thermo-e.m.f. is negative and it is positive above. For p-type the value of σ increases three-fold between 1 and 7000 kg/cm^2 but the change for n-type is small. The results can be explained by production of a pressure-dependent number of acceptor levels, the mobilities and gap width being little changed. The known defect structure may be responsible for this and for the observed hysteresis. R.Berman

539.2 : 537.311

13616 WEAK-FIELD MAGNETORESISTANCE IN p-TYPE LEAD TELLURIDE AT ROOM TEMPERATURE AND 77°K.
R.S.Allgaier.

Phys. Rev., Vol. 119, No. 2, 554-61 (July 15, 1960).

The weak-field magnetoresistance of six single crystals of p-type PbTe was measured at room temperature and 77°K. The general predictions of weak-field theory were precisely obeyed the range of magnetic-field intensities for which the theory shou apply. In stronger fields at 77°K, deviations from weak-field behaviour of three types were observed which agree with the Gold–Roth theory of magnetoresistance at arbitrary magnetic-f strengths. The weak-field data at both temperatures conformed very closely to the $\langle 111 \rangle$ ellipsoid-of-revolution multivalley mo with values of the mass and scattering-time anisotropy paramet K of 4.7 (room temperature) and 4.2 (77°K), and with values of t statistical-scattering factor G of 1.17 (room temperature) and 1.016 (77°K). The dependence of the magnetoresistance at 77°K the Fermi level was used to make a rough calculation of the effe mass components of the carriers in p-type PbTe which led to a density-of-states effective mass of 0.16 times the free electron mass. Some preliminary room-temperature magnetoresistance data on n-type PbTe and on PbS and PbSe were also obtained wh revealed that the longitudinal magnetoresistance in both n- and p-type PbS and PbSe was an order-of-magnitude smaller than in p-type PbTe.

539.2 : 53

13617 COMPOSITION LIMITS OF STABILITY OF PbTe.
R.F.Brebrick and R.S.Allgaier.

J. chem. Phys., Vol. 32, No. 6, 1826-31 (June, 1960).

Single crystals of PbTe have been heat-treated in evacuate silica tubes in the presence of Pb- or Te-rich ingots. At the he treatment temperatures, which ranged between 404° and 885°C, ingot compositions were such that solid PbTe, liquid, and vapou phases coexisted. At a given temperature, the PbTe crystals w therefore as rich in Pb or Te as possible at equilibrium. After quenching the crystals, the resistivity and Hall constant were m ured at room temperature and 77°K. Below about 860°C, cryst heated with Pb-rich ingots were n type. Those heated with Te- ingots were p type at all heat-treatment temperatures. The diff ence in the concentrations of electrons and holes at room tempe ture was taken as equal to the difference in concentration of lea and tellurium atoms at the heat-treatment temperature and was used to construct the PbTe solidus lines. The range of stability PbTe is a maximum near 775°C and is between 49.994 and 50.013 at.% Te, corresponding to carrier concentrations of 3.3 electron/cm^3 and 7.6×10^{18} holes/cm^3, respectively.

539.2 : 537.311 : 5

13618 THE CHARGE AND POTENTIAL DISTRIBUTIONS A THE ZINC OXIDE ELECTRODE. J.F.Dewald.

Bell. Syst. tech. J., Vol. 39, No. 3, 615-39 (May, 1960).

Capacitance measurements made on single crystal zinc oxi electrodes in contact with aqueous electrolytes are reported. C a wide range of bias and bulk donor density, the results are in a most quantitative accord with predictions of the simple Poisson Boltzmann (Poisson–Fermi in the degenerate case) equation. is shown to imply the complete absence of surface-state effects this system. A very sharp discontinuity in the flat-band potent is observed at bulk electron densities in the range from 0.6 × 1 to 2×10^{18} cm^{-3}. This and other effects, arising under varying face treatments, are discussed in some detail. The use of the s conductor/electrolyte interface in studying the properties of low lying donors is illustrated for the case of boron, which is show lie about 0.3 eV below the conduction band.

539.2 : 53

13619 THE CONTRIBUTION OF A SINGLET EXCITATIO STATE TO THE ELECTRICAL CONDUCTIVITY OF SERIES OF ORGANIC SEMICONDUCTORS.
A.T.Vartanyan and L.D.Rozenshtein.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 2, 279-82 (March 11, 196 In Russian.

The dark conductivity and long wavelength absorption spect were measured for several dyes. When the solid layers were f by sublimation good agreement was found between the two activ energies. Since the energies were different from those associa with phosphorescence and the triplet states it was concluded th they correspond to singlet states. D.J.Hu

539.2 : 53

13620 CHARGE CARRIER PRODUCTION AND MOBILITY ANTHRACENE CRYSTALS. R.G.Kepler.

Phys. Rev., Vol. 119, No. 4, 1226-9 (Aug. 15, 1960).

The drift mobilities of electrons and holes in anthracene c were measured using a pulsed photoconductivity technique. Th

ilities found at room temperature vary from ~0.3 to ~3 cm^2/V sec,
nding on the crystal orientation, and the mobilities increase as
emperature is lowered. The wavelength dependence of the
ber of charge carriers produced by a pulse of light, as well as
r experimental data, indicates that the charge carriers are not
uced in the interior of anthracene crystals, but that they are
ased from a surface layer of the crystal either directly by
ons or by excitons which migrate to the surface.

539.2 : 537.311

3621 ORGANIC SEMICONDUCTORS. I. SOME CHARACTERISTICS OF THE β-PHENYLENEDIAMINE-CHLORANIL
PLEX. M.M.Labes, R.Sehr and M.Bose.
em. Phys., Vol. 32, No. 5, 1570 (May, 1960).
Conductivity versus temperature plots for several samples are
n and the Seebeck coefficient is reported. This has the high
e of 1.1 mV/°C, approximately constant over the temperature
e +49° to -36°C. K.W.Plessner

539.2 : 537.311

3622 CONDITIONS FOR THE APPLICATION OF DOUBLE DIFFUSION TO PRODUCE GERMANIUM TRANSISTORS.
schamps.
Acad. Sci. (Paris), Vol. 250, No. 20, 3290-2 (May 16, 1960).
rench.
In a previous note (Abstr. 11686 of 1960) the required conditions
his method were given together with the calculated concentration
iles which should result. The experimental methods by which
heory has been verified and which have resulted in the produc-
of n—p—n structures are described. The impurities whose
sion is studied are indium and arsenic. Alloying to the diffused
s is described. Three graphs. W.Bardsley

539.2 : 537.311 : 621.382.2

3623 ON THE THERMAL TURNOVER OF GERMANIUM RECTIFIERS. E.Nagy.
phys. Hungar., Vol. 8, No. 1-2, 231-3 (1957).
It is shown that the dependence of turnover voltage on resistivity
mobility is the same as that deduced from the Zener breakdown
hanism.

539.2 : 537.311 : 621.314.632

3624 ON THE SURFACE CONDUCTIVITY OF CUPROUS OXIDE RECTIFIERS. M.M.Kalabin and P.V.Sharavskii.
tverdogo Tela, Vol. 2, No. 5, 857-62 (May, 1960). In Russian.
The V—A characteristics of a large number (~ 700) of Cu_2O
ifying pellets of various diameter (2-7 mm) were determined.
as found that the reverse current depended not only on the
luctivity of the pn-junction (volume current), but also on the
ace conductivity (edge current), the latter becoming particularly
rent in pellets of small diameter. It was postulated that with
easing curvature of the edge of the pellet the number of the
ace levels and, consequently, the surface conductivity increase.
M.H.Sloboda

539.2 : 537.311 : 621.382.2

3625 DIODE CAPACITORS FOR PARAMETRIC AMPLIFICATION. R.C.Knechtli and R.D.Weglein.
pl. Phys., Vol. 31, No. 6, 1134-5 (June, 1960).
Proposes a definition of the figure of merit of a diode capacitor
h differs from that given previously by Mortenson (Abstr. 13315
959). The new definition predicts an optimum doping level
^{17} donors/cm^3 for a Ge abrupt junction diode, which minimizes
noise temperature. It is claimed that this prediction is borne
n practice. G.D.Sims

539.2 : 537.311 : 621.382.2

3626 COMMENTS ON "DIODE CAPACITORS FOR PARAMETRIC AMPLIFICATION" BY R.C.KNECHTLI AND
WEGLEIN. K.E.Mortenson.
pl. Phys., Vol. 31, No. 6, 1135 (June, 1960).
See preceding abstract. The author points out that his figure
erit differs from that proposed by Knechtli and Weglein only in
recise definition of the parameters used. A further improved
ition (to be substantiated in a forthcoming paper) involving a
ier capacitance coefficient of the pumped diode is given. The
or defends his previous contention that the figure of merit of
pt junction Ge diodes increases with decreasing doping.
G.D.Sims

539.2 : 537.311 : 621.382

13627 SPREADING RESISTANCE IN CYLINDRICAL SEMICONDUCTOR DEVICES. D.P.Kennedy.
J. appl. Phys., Vol. 31, No. 8, 1490-7 (Aug., 1960).

For cylindrical semiconductor components, computation of spreading resistance is considered a boundary value problem of the solid circular cylinder. Solutions of this problem may be used, for example, to characterize the thermal spreading resistance within the package of a semiconductor device, the electrical spreading resistance in a mesa-type parametric diode, and the extrinsic collector resistance of a mesa transistor. Equations describing the thermal (or electrical) spreading resistance are presented in graphical form for a range of geometrical parameters applicable to many practical situations. Further, examples are given for the potential distribution within each cylindrical structure considered in this analysis.

539.2 : 537.311

13628 DIRECT OBSERVATION OF POLARONS AND PHONONS DURING TUNNELING IN GROUP 3—5 SEMICONDUCTOR JUNCTIONS. R.N.Hall, J.H.Racette and H.Ehrenreich.
Phys. Rev. Letters, Vol. 4, No. 9, 456-8 (May 1, 1960).

The electrical characteristics of tunnel diodes made from III—V compounds show at 4.2° K a structure which is related to the polar character of the compounds and whose magnitude is linked with the polar electron—phonon coupling constant. Threshold voltages are observed corresponding to the energy necessary for the creation of a long wavelength longitudinal optical phonon. Details are given of InSb, InAs, InP, GaSb, GaAs and GaP diodes.
C.Hilsum

Photoconductivity

539.2 : 537.312

13629 EFFECT OF ELECTRIC FIELDS ON HYDROGEN-LIKE EXCITONS. J.W.Allen.
Nature (London), Vol. 187, No. 51, (July 2, 1960).

Calculation shows that small electric fields polarize an exciton but that ionization will occur above a certain critical field. The theory suggests that with an applied electric field excitons will migrate to grain boundaries but will be destroyed there by the larger fields. Since long-range photo-effects in gallium arsenide are unaffected by grain boundaries it is suggested that excitons can not play an important role. D.J.Oliver

539.2 : 537.312

13630 SATURATION OF PHOTOCURRENT WITH LIGHT INTENSITY. R.H.Bube.
J. appl. Phys., Vol. 31, No. 7, 1301-2 (July, 1960).

The effect is observed in pure single crystals of CdS, made photosensitive by an annealing treatment. The results indicate that in such crystals the density of levels throughout the forbidden gap is less than 10^{14} cm^{-3}. C.Hilsum

539.2 : 537.312

13631 TRAPPING AND DIFFUSION IN THE SURFACE REGION OF CADMIUM SULFIDE. J.J.Brophy.
Phys. Rev., Vol. 119, No. 2, 591-6 (July 15, 1960).

For previous work, see Abstr. 9991 of 1960. In lightly doped single crystal CdS illuminated with 4400 A radiation hole-electron pairs generated at the surface diffuse into the crystal until the hole is trapped. The electrons experience multiple retrapping until they disappear through recombination. Current noise and photoconductivity measurements were used to study these processes. The noise data establish the ambipolar diffusion length as 30 microns, confirm that diffusion is important though the appearance of a $f^{-3/2}$ trend in the noise spectra, and show that discrete traps are located the same distance below the conduction band in the surface regions as in the bulk. Discrete trap levels at 0.35, 0.40 and 0.43 V below the conduction band are observed in the surface region. Trap densities of 10^{16} traps/cm^3 V, an order of magnitude greater than that in the bulk, are determined. The trap frequency factors are of the order 10^{10} sec^{-1}.

539.2 : 537.312

13632 ON THE MECHANISM OF PHOTOCONDUCTIVITY OF SINGLE CRYSTALS OF THE CADMIUM SULPHIDE TYPE. M.K.Sheinkman.
Fiz. tverdogo Tela, Vol. 2, No. 6, 1155-9 (June, 1960). In Russian.

It is shown analytically that many experimentally determined facts, relating to the photoconductive properties (such as the lux/ampere characteristics or the effects of the intensity of illumination, L, on the photocurrent yield, a_g, and its relaxation time, τ^0) of single crystals of the CdS type, can be made to fit the hypothesis according to which excitons play an important part in the photoconductive phenomena, taking place in crystals of this type. In the variant of this hypothesis, also discussed, the relationship $\tau^0 \sim L^{-1}$ is attributed to quasi-bimolecular recombination of the photo-carriers, and a concept of triple collisions (collision of two excitons on an impurity defect, collision between an exciton and a free carrier on an impurity defect, or interaction between an exciton and a phonon near a charged electron trap) is introduced to explain the relationship $a_g \sim L$. M.H.Sloboda

539.2 : 537.312

13633 ON THE INFLUENCE OF HEAT TREATMENT ON THE PHOTO-E.M.F. OF CUPROUS OXIDE. I.D.Kirvalidze.
Fiz. tverdogo Tela, Vol. 2, No. 6, 1152-4 (June, 1960). In Russian.

Briefly reports an investigation of the effect on photo-conductivity of various amounts of oxygen contained in (nominal) cuprous oxide. The amount of oxygen was varied by altering the time for annealing (at about 250°C). To avoid placing contacts on the specimen an arrangement was used in which the illuminated specimen formed the control grid of a triode valve. Results of photo-current versus annealing time are given. T.Mulvey

539.2 : 537.312

13634 DETERMINATION OF THE RECOMBINATION CONSTANTS FROM THE PHOTOCONDUCTIVITY SPECTRUM. V.K.Subashiev, V.A.Petrusevich and G.B.Dubrovskii.
Fiz. tverdogo Tela, Vol. 2, No. 5, 1022-4 (May, 1960). In Russian.

Two methods of determining the surface recombination rate, s, and the length, L, of the volume diffusion from the photoconductivity spectrum are proposed. The methods are sufficiently simple to be applied under industrial conditions, and have been successfully used for determination of s and L in Ge and Si. M.H.Sloboda

539.2 : 537.312

13635 SPECTRAL DISTRIBUTION OF THE PHOTOMAGNETO-ELECTRIC EFFECT IN Ge : EXPERIMENT.
F.A.Brand, A.N.Baker and H.Mette.
Phys. Rev., Vol. 119, No. 3, 922-5 (Aug. 1, 1960).

The photomagnetoelectric (PME) effect was studied in germanium as a function of the wavelength of incident radiation in the region from 0.5 to 2.0μ. The dependence of both photoconductivity and PME response was measured in various samples, using front and back surface recombination velocities and bulk recombination as parameters. It was found that under certain conditions of bulk and surface recombination a reversal in sign for the PME response occurs over the frequency range studied. Sign reversals obtain at wavelengths in the range from 1.55 to 1.85μ, corresponding to partial optical transparency. The exact frequencies at which reversal occurs depend on the surface and bulk recombination rates, the condition being that the Dember field be zero corresponding to equal carrier concentrations on the front and back surfaces. Furthermore, the present observations are shown to be in good qualitative agreement with the theoretical work reported by Gärtner (Abstr. 3262 of 1957). Experimental procedures are described, and it is shown how this effect can be used to advantage in the study of surface recombination velocities in various environments.

539.2 : 537.312

13636 PHOTOELECTRIC EMISSION AND WORK FUNCTIONS OF InSb, GaAs, Bi_2Te_3 AND GERMANIUM. D.Haneman.
J. Phys. Chem. Solids, Vol. 11, No. 3-4, 205-14 (Oct., 1959).

Measurements have been made of the energy distributions of photoelectrons emitted by various semiconductor surfaces freshly exposed by breaking in high vacuum ($\sim 10^{-8}$ mm). The data have been used to obtain the variation with energy of the density of states in the valence band, multiplied by a photoelectric excitation probability. Spectral distributions of the photoelectric yield and accelerating field characteristics were also measured. Marked differences were found between the energy-dependence of the photoemission of the hexagonal structure Bi_2Te_3 on the one hand, and the three diamond-structure semiconductors on the other. Work functions found were: 4.57 eV for InSb, 4.69 eV for GaAs, and 4.75 eV for germanium, the clean faces being composed of (110) facets for the intermetallic semiconductors and of (111) facets for the germanium. For Bi_2Te_3, mirror-like (0001) cleavage planes had a work function of 5.30 eV.

539.2 : 537.3

13637 THE OPEN CIRCUIT ELECTROMOTIVE FORCE OF A SELENIUM PHOTOCELL AT LOW TEMPERATURES. G.Blet.
J. Phys. Radium, Vol. 19, No. 2, 166-9 (Feb., 1958). In French.

The e.m.f. increases rapidly as the temperature decreases. This variation is approximately proportional to that of the resist
Assumptions made concerning the internal mechanism of photoce
are verified and a general expression independent of the photocel
size is given. Notwithstanding irregular manufacture, a good enc
quantitative check was obtained.

539.2 : 537.

13638 THE SPECTRAL AND TEMPERATURE DEPENDEN
OF THE QUANTUM EFFICIENCY IN SILICON.
V.S.Vavilov and K.I.Britsy̆n.
Fiz. tverdogo Tela, Vol. 1, No. 10, 1629-31 (Oct., 1959). In Russ

New data on the quantum efficiency of photoionization in Si i
given for photon energies up to 4.9 eV. The quantum efficiency i
temperature dependent in the region of energies where impact ionization occurs. Reasons for this dependence are given.
R.B.Stinchco

Thermoelectric Properties

539.2 : 53

13639 THE INFLUENCE OF THE TEMPERATURE DEPEN
ENCE OF PROPERTIES OF MATERIALS ON THE EFFICIENCY OF THERMOELECTRIC GENERATORS AND REFRIGERATORS. B.Ya.Moizhes.
Fiz. tverdogo Tela, Vol. 2, No. 4, 728-37 (April, 1960). In Russi

For a generator the fractions of the Joule and Thomson heat
which flow to the hot end of the element are derived as functions
the temperature dependences of the thermal conductivity, electri
resistance and Thomson coefficient. The efficiency and conditio
for maximum efficiency are obtained. For a refrigerator workin
over a small temperature interval the variations of the paramet
with temperature are treated as a perturbation on the temperatu
independent situation. A figure shows the ratios of coefficient of
performance and heat extracted to the values which would obtain
for temperature-independent parameters, and also the influence
a non-uniform temperature distribution for the case of constant
parameters. R.Ber

539.2 : 53

13640 INTERPRETATION OF RELATIVE THERMOELECT
PHENOMENA AT LOW TEMPERATURES WITH SPECIAL CONSIDERATION OF THE EFFECTS OF COLD-WOR
ON COPPER. W.B.Pearson.
Phys. Rev., Vol. 119, No. 2, 549-53 (July 15, 1960).

Formulae first derived by Kohler (1949) and more recently
discussed by MacDonald are used to account for relative thermo
electric effects at low temperatures in pure metals, dilute alloy
and in cold-worked copper. Since calculations based on these fo
ulae give diffusion thermoelectricity, phonon drag contributions
thermoelectricity should appear as differences between the calc
ated and measured curves of thermoelectric power as a function
temperature.

539.2 : 537.32 : 621.385.032.2

13641 THE CONDUCTIVITY OF OXIDE CATHODES. IX. THERMO-ELECTRIC POWER.
G.H.Metson and M.F.Holmes.
Proc. Instn Elect. Engrs, Monogr. 397E, publ. Sept., 1960, 10 p
To be republished in Part C.

For Pt VIII, see Abstr. 894 B of 1960; Proc. Instn Elect. E
Monogr. 357E, Vol. 108 C, 158-62 (Sept., 1960). The thermoelec
power of an oxide cathode has been examined by Young (Abstr.
of 1953), who finds it to be a complex function of temperature,
dependent on the dual nature of oxide-cathode conductivity. By
experimental artifice the present authors show that an apparent
complex form of behaviour is, in fact, the result of the superposition of two quite simple phenomena. Two parallel-acting th
electric power functions are involved, and each of these is inva
with temperature and temperature gradient. The two functions
physically separated and each is measured over an appropriate
temperature range. The larger function, of magnitude 2.0-3.0 mV
is associated with the vacuum movement of electrons through t

ow pores of the oxide matrix; the smaller one, of magnitude mV/degC, occurs in the chains of contiguous solid particles of matrix. Owing to the parallel connection and inequality of these tions, it is concluded that a temperature gradient through an e matrix leads to a continuous circulation of current, vacuum- in one direction and solid-wise in the other. Since the larger tion is essentially one involving thermionic emission of electrons vacuum, it can be satisfactorily explained in terms of Richard- s law.

ectric Properties

539.2 : 537.2

3642 DIELECTRIC RELAXATION AND FREE VOLUME. N.E.Hill.

ns Faraday Soc., Vol. 55, Pt 12, 2000-4 (Dec., 1959).

The equation $\zeta = A'/(v - b')$ is proposed for the dependence of inner friction constant ζ on specific volume v, by analogy with schinski's equation for viscosity $\eta = A/(v - b)$. Polar substances then be divided into two classes, corresponding to the two cases b and $b' < b$. This classification is found to agree with an lier one based on the behaviour of the static dielectric constant ne freezing point.

539.2 : 537.2 : 621.382

3643 CONTACT ELECTRIFICATION OF SEMICONDUCTORS. W.R.Harper.

. J. appl. Phys., Vol. 11, No. 8, 324-31 (Aug., 1960).

Recently published experimental findings on the electrification utile powder by sliding down a metal chute can be explained by xtension of the author's theory of the separation electrification etals. The mechanism of the electrification of insulators must, ost cases, be quite different.

539.2 : 537.2

13644 HIGHER-ORDER TERMS IN THE DIELECTRIC CONSTANT OF IONIC CRYSTALS. B.Szigeti.

c. Roy. Soc. A, Vol. 252, 217-35 (Sept. 8, 1959).

The infrared absorption of ionic crystals differs in important ails from the predictions of the theory based on first approxi- tions. It is known that this discrepancy may be due to two effects ch are neglected in such a theory, namely, to the anharmonic ms in the potential energy and to those in the dipole moment ch are of higher order than the first in the displacement coordi- es. These higher-order terms in the dipole moment arise from deformation of the electron shells. This paper develops in a tematic way the influence of these higher-order effects on the ic dielectric constant. Because of the dispersion relations, the ms occurring in the static dielectric constant must also appear he infrared absorption spectrum. It is found that the third- and fourth-order potential, the second- and the third-order dipole ment, and cross-terms between the second-order moment and third-order potential, all contribute terms in the same order to static dielectric constant. It is also found that the third-order ential contains important contributions from the long-range lar interaction. These dipolar contributions are proportional to product of the first-and second-order dipole moments, and it ows that in ionic crystals a large second-order moment auto- ically results in a large third-order potential. It is suggested these dipolar contributions to the third-order potential may be ponsible for the fact that in the infrared spectra of different ionic stals not only the intensity of the side band but also the width of main band varies in the same way as the deformability of the tron shells.

539.2 : 537.2

13645 THE TEMPERATURE DEPENDENCE OF PERMITTIVITY OF IONIC DIELECTRICS OVER A WIDE RANGE OF MPERATURES.

.Aleksandrov, N.P.Bogoroditskii, K.E.Lisker and I.D.Fridberg. tekh. Fiz., Vol. 30, No. 6, 699-704 (June, 1960). In Russian.

Permittivity and loss tangent were measured on sintered disks wide variety of materials, including silicates, aluminates, nates, zirconates, and stannates. The temperature coefficient ermittivity is shown as a function of temperature between −150 +150°C. The variation with temperature is discussed in relation he relaxation mechanism and the ionic nature of the materials.

R.F.S.Hearmon

539.2 : 537.2

13646 CONTRIBUTION TO THE THEORY OF THE DIELECTRIC PROPERTIES OF THE ALKALI HALIDES. E.E.Havinga

Phys. Rev., Vol. 119, No. 4, 1193-8 (Aug. 15, 1960)

Some relations between dielectric properties of diagonal cubic ionic crystals are derived on the basis of the shell model for ions of Dick and Overhauser (Abstr. 4542 of 1959). The relations, which contain no model constants, are in a good agreement with experimental data. Also it is shown that Dick and Overhauser overestimated the number of electrons in the shells of the ions, which accounts for the failure of their quantitative treatment. The work of Hanlon and Lawson is also discussed

539.2 : 537.2 : 548.7

13647 DIELECTRIC BEHAVIOR AND CRYSTAL STRUCTURE OF ETHYL AND VINYL STEARATE.

M.G.Broadhurst and E.R.Fitzgerald.

J. chem. Phys., Vol. 33, No. 1, 210-20 (July, 1960).

Measurements of the real (ϵ') and imaginary (ϵ'') components of the complex dielectric constant were made on ethyl and vinyl stearate and on mixtures of ethyl stearate in n-heneicosane at temperatures from +60° to −80°C and over a frequency range from 100 to 50 000 c/s. A relaxation dispersion region, which was similar in shape and position for all samples, occured below 0°C for the frequency range considered. The magnitudes of the dispersions were found to be greater the more quickly the samples were frozen, and very much reduced for samples crystallized from acetone. Annealing of the solid samples at temperatures as low as 20 deg C below the freezing points resulted in a gradual decrease in polarization. Cooling curve data was obtained in order to supplement the above work. The results suggest that the molecular rotations involved in the observed solid state dispersions are associated with metastable crystal structures and that, in particular, the decrease in polarization with time is due to a gradual transformation in parts of the sample from a vertical to a tilted crystal structure.

539.2 : 537.2

13648 THEORETICAL DIELECTRIC BEHAVIOR OF AN ETHYL STEARATE—HENEICOSANE MIXTURE.

M.G.Broadhurst.

J. chem. Phys., Vol. 33, No. 1, 221-6 (July, 1960).

The variation in potential energy with position for an ethyl stearate molecule rotating rigidly about its chain axis in a heneicosane lattice is found by evaluating the potential energy of the component atoms at 18 angular positions of the molecule. The potential energy function considered involves attractive van der Waals terms in the inverse sixth, eighth, and tenth powers of the distance and an exponential repulsive term. The resulting potential energy curve is used to find possible molecular motions, and calculations of the predicted dielectric relaxation dispersion are made. The model predicts only two positions available to the ethyl stearate molecule and hence only one dielectric relaxation time. Exact calculations of the dielectric properties of a mixture of ethyl stearate in heneicosane are found to be difficult because of the extreme sensitivity of the results to slight errors in the assumed energy function.

539.2 : 537.2

13649 CAPACITANCE MEASUREMENTS ON THE SILICON—ELECTROLYTE BOUNDARY LAYER. K.Böke.

Z.Naturforsch., Vol. 15a, No. 5-6, 550-1 (May-June, 1960). In German.

Very thin laminae of Si were immersed in an electrolyte and the capacitance was measured at an increasing reverse bias. As the thickness of the barrier layer approached half the lamina thickness, the base connection became ineffective and the measured capacitance dropped sharply. It is shown in this way that a classical barrier layer existed in the Si, and that there was no inversion layer.

K.W.Plessner

539.2 : 537.2 : 548.5

13650 GROWING CRYSTALS OF L-RHAMNOSE MONOHYDRATE AND THE STUDY OF THEIR DIELECTRIC, PIEZO-ELECTRIC, AND ELASTIC PROPERTIES [BY DYNAMIC METHODS].

A.A.Chumakov, I.M.Sil'vestrova and K.S.Aleksandrov.

Kristallografiya, Vol. 3, No. 4, 480-2 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 478-80 (July - Aug., 1958).

Large (weight up to 285 g) and perfect crystals were grown from solutions in water and ethyl alcohol, and from aqueous alcoholic solutions of different concentrations. The crystals grew very well from aqueous solutions in the temperature range 30-60°C, if the solution was supercooled by 1-3°C and the crystal rotated rapidly (200-500 rev/min) in the solution. It is shown that a combination of the impulse method of measuring the elastic moduli of a crystal with the resonance method of determining its piezoelectric moduli enables the measurements to be simplified.

539.2 : 537.2 : 538.2

DIELECTRIC PROPERTIES OF YTTRIUM IRON GARNET.

See Abstr. 11896

539.2 : 537.2

13651

ON THE ISOTOPIC EFFECTS IN THE FERROELECTRIC BEHAVIOUR OF CRYSTALS WITH SHORT HYDROGEN BONDS.

R.Blinc.

J. Phys. Chem. Solids, Vol. 13, No. 3-4, 204-11 (June, 1960).

An attempt to correlate the isotopic effects in the ferroelectric properties of hydrogen-bonded crystals with the observed anomalies in their i.r. and n.m.r. spectra has led to the conclusion that the protons in the hydrogen bonds are tunnelling in double-minimum potential fields. The ferroelectric transition is assumed to be the result of a deformation of the protonic distribution due to electrostatic interactions. It has been found that a quantum-mechanical extension of Mason's and Devonshire's long-range-forces model is able to explain, by the same mechanism, the results of i.r. and n.m.r. spectroscopy as well as the dependence of the Curie point on the mass of the hydrogen isotope, the sharper increase of the spontaneous polarization with falling temperature and the larger value of the spontaneous polarization at absolute zero for deuterated than for hydrogen compounds. The proposed model predicts that a ferroelectric transition occurs only if the dipole—dipole interactions, expressed as frequencies, are greater than the tunnelling frequency on the lowest vibrational level.

539.2 : 537.2 : 538.2

FERROELECTRIC AND FERRIMAGNETIC PROPERTIES OF $(Ba_{6-2x}R_{2x})(Nb_{9-x}Fe_{1+x})O_{30}$.

See Abstr.11900

539.2 : 537.2

13652

NONSTOICHIOMETRY AND FERROELECTRIC PROPERTIES OF $PbNb_2O_6$-TYPE COMPOUNDS.

E.C.Subbarao and G.Shirane.

J. chem. Phys., Vol. 32, No. 6, 1846-51 (June, 1960).

The crystal structure of $PbNb_2O_6$ consists of a framework of NbO_6 octahedra linked through corners. The Pb^{2+} ions occupy 5 out of the 6 available interstitial sites in this framework. Single-phase compositions have been prepared by solid-state reactions to yield nonstoichiometric compounds of the form $A_{1+x}B_2O_6$ where A and B may consist of two ions of different valency and x has values between -0.08 and 0.15. In these materials, the number of unfilled interstitial sites inherently present in $PbNb_2O_6$ lattice has been varied. Lattice parameter and X-ray intensity data confirm that the additional ions introduced occupy the same sites as Pb^{2+} ions. The ferroelectric Curie temperature has been studied as a function of the composition of these dielectric solids. For compositions with $x > 0$, the Curie temperature is not very sensitive to composition. As the number of unfilled interstitial sites increases ($x < 0$), the Curie temperature decreases sharply.

539.2 : 537.2

13653

MEASUREMENT OF THE DIELECTRIC NON-LINEARITY OF ROCHELLE SALT.

H.E.Müser.

Z. angew. Phys., Vol. 12, No. 7, 300-6 (July, 1960). In German.

The purpose of the measurements was to derive the coefficients in the power series relating electric field E and displacement D. By displaying D/E hysteresis loops and the time derivatives of D and E on a C R.O., the coefficients of D and of D^3 were determined over a range of temperatures, that of D^5 being to small to be detected. A discrepancy in the ferroelectric region between the linear term derived in this way and from measurement of the low-voltage permittivity is ascribed to the domain structure of the crystals.

K.W.Plessner

539.2 : 537.2

13654

PUCKERING PHASE TRANSITIONS.

V.A.Isupov.

Kristallografiya, Vol. 4, No. 4, 603-8 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 4, 564-8 (April, 1960).

A discussion is given of the nature of the phase transitions in calcium and strontium zirconates, stannates, cerates, titanates, etc. The possible positions of the electric moments are considered in relation to the pseudocubic unit cells that are present below the transition points. The discussion turns on the difference betwee ferroelectric transitions and puckering transitions. The phase transitions in some compounds and solid solutions are considere

539.2 : 5

13655

DIELECTRIC INVESTIGATION OF PEROVSKITE TY FERROELECTRICS. I. FERROELECTRIC SYSTEM WITH SMALL TEMPERATURE COEFFICIENT OF PERMITTIVI

Z.Pająk.

Acta phys. Polon., Vol. 18, No. 5, 473-506 (1959).

Three methods of obtaining ferroelectric systems with a sm temperature coefficient of the permittivity TC ϵ are presented. first consists in connecting in parallel two ferroelectric condens whose TC ϵ differ in sign, the second in composing heterogeneou systems from two or three different $BaTiO_3-SrTiO_3$ solid soluti and the third in composing $BaTiO_3-MgSnO_3$ solid solutions. The last method is the best, yielding $|TC\ \epsilon| < 200 \times 10^{-4}\ deg^{-1}$ and a rather high value of the permittivity. The TC $\epsilon(T)$ dependence n the ferroelectric transition temperature is discussed. From the dielectric properties investigated, the $BaTiO_3-MgSnO_3$ solid sol tions reveal a behaviour typical of other perovskite type ferroelectrics.

539.2 : 5

13656

DIELECTRIC INVESTIGATION OF PEROVSKITE TY FERROELECTRICS. II. AGEING PROCESS IN FERROELECTRICS.

Z.Pająk.

Acta phys. Polon.,Vol. 18, No. 5, 507-20 (1959).

The dielectric behaviour of $BaTiO_3$ type ferroelectrics in th process of ageing was investigated and new ageing effects were detected. It was found that the Curie point (i.e. the temperature the paraelectric-ferroelectric transition) is displaced towards higher temperatures and the spontaneous polarization, coercive and hysteresis losses vanish in the process of ageing. A domain mechanism of ageing leading to the formation of domain antiferr electrics is proposed, and some related effects such a rejuvenat and delay effects are discussed.

539.2 : 5

13657

COMPARISON OF THE INTERNAL FIELDS ACTING CERTAIN FERRO- AND ANTIFERROELECTRIC STRUCTURES OF THE PEROVSKITE TYPE.

N.N.Krainik.

Fiz. tverdogo Tela, Vol. 2, No. 5, 993-6 (May, 1960). In Russian

Factors affecting transitions between ferro- and antiferroelectric structures demand knowledge of the internal fields. Th were worked out for several structures of the perovskite type as function of the size of the unit cells and the polarizability of the forming the crystal lattice. This shows that, other things being equal, the relative stability of the antiferroelectric structure increases with diminishing polarizability of the anions and with increasing cell size.

A.E.I. Research Labora

539.2 : 5

13658

TRANSIENT PHENOMENA OF CONDUCTIVITY IN $BaTiO_3$ CERAMIC WITH DIRECT CURRENT.

V.M.Gurevich and I.S.Rez.

Fiz. tverdogo Tela, Vol. 2, No. 4, 673-8 (April, 1960). In Russ

The authors report measurements of the slow change of conductivity with time of barium titanate in the presence of a polarizing field, with a steady current passing through the spec The effect is greatest just below the Curie temperature and does occur above this temperature. Other experimental evidence is g to show that the effect is associated with ferroelectric propertie It is suggested that the effect may be of great value in investigat ferroelectric properties of new materials.

A.E.I. Research Laborat

539.2 : 5

13659

METHODS OF MEASURING A HIGH-VOLTAGE POLARIZATION POTENTIAL.

O.I.Prokopalo.

Fiz. tverdogo Tela, Vol. 2, No. 2, 302-5 (Feb., 1960). In Russian

The equivalent circuit of a polarized dielectric is complicat in the general case but can be used (1) when a thin layer is form at the electrode, (2) when the potential distribution is linear. Th equivalent circuits in these two cases throw light on the limits within which each of the various methods proposed for measurin polarization in dielectrics can be applied. An expression is fou for the recorded electrometer potential as a function of time in case of a linear distribution and verified by an experimental cu for $BaTiO_3$.

D.E.Br

539.2 : 537.2

13660 THE QUESTION OF THE ELECTRET STATE IN NAPHTHALENE.

M.Beliaev, G.S.Belikova, V.M.Fridkin and I.S.Zheludev.
stallografiya,Vol. 3, No. 6, 762 (Nov.-Dec., 1958). In Russian.
glish translation in: Soviet Physics–Crystallography (New York),
. 3, No. 6, 772-3 (Jan., 1960).

Thermoelectrets were formed from melted naphthalene, and to- and thermoelectrets from single crystals of naphthalene. In cases it was possible to depolarize completely the electrets by minating them with a mercury vapour lamp. The results indicate t there is no sharp demarcation between photo- and thermoelectret tes, and that in both, the heterocharge is probably due to localized ctrons. L.E.Cross

539.2 : 537.2

13661 PHOTO-ELECTRET STATE IN ZINC SULPHIDE AND TWO NEW ELECTRO-PHOTOGRAPHIC PROCESSES.

M.Golovin, N.T.Kashukeev, I.N.Orlov and V.M.Fridkin.
. tverdogo Tela, Vol. 2, No. 5, 1004-10 (May, 1960). In Russian.

The photo-electret characteristics of polycrystalline ZnS, ivated with Cu and Cl and exhibiting electroluminescent perties, were studied. The effect of the intensity of the polar- ng field and the energy of illumination on the charge of ZnS to-electrets was determined, and curves, illustrating the polar- tion (dark, photo, and total) phenomena, were constructed. One he particularly interesting properties of ZnS photo-electrets was ir capability of being depolarized by the application of an alter- ing electrical field, the depolarization process being accom- ied by electroluminescence of the photo-electret. It was postu- d that these effects may have some bearing on the formation of ges on electro-photographic ZnS and ZnO films, depolarized in alternating electrical field. M.H.Sloboda

539.2 : 537.2

13662 PROCESSES PRIOR TO ELECTRICAL BREAKDOWN IN SINGLE CRYSTALS OF CdS. K.W.Böer and U.Kümmel

angew. Phys., Vol. 12, No. 6, 241-4 (June, 1960). In German.

Breakdown is divided into two types, thermal and field break- vn. In relatively conducting crystals, Joule heating is followed non-uniform heating forming "canals" of high current density, process being irreversible after their formation. For insulating stals Joule heating is not in evidence until after the field akdown effect which occurs at a critical applied voltage. The d breakdown is characterized by a very short relaxation time. G.F.J.Garlick

539.2 : 537.2

13663 PYROELECTRIC EFFECT IN THE CUBIC ZnS STRUCTURE. R.Landauer.

hem. Phys., Vol. 32, No. 6, 1784-5 (June, 1960).

The classical theory of pyroelectricity, which uses only the nmetry of the crystal class, is shown to be incorrect. The sur- e structure is also relevant. The case of cubic ZnS is discussed letail.

539.2 : 537.2

13664 STUDY OF THE PROCESSES OF PIEZOELECTRIC POLARIZATION OF ROCHELLE SALT CRYSTALS BY SERVATION OF THEIR DOMAIN STRUCTURE.

.Zheludev and N.A.Romanyuk.
istallografiya, Vol. 4, No. 5, 710-17 (Sept.-Oct., 1959). In
ssian. English translation in: Soviet Physics—Crystallography
w York), Vol. 4, No. 5, 670-8 (May, 1960).

By observing the domain structure of Rochelle salt crystals in arized light, a study was made of the processes of piezoelectric arization in the direction of the ferroelectric axis. It was found t for slow changes (stresses approaching the coercive stress) the a S of the increasing domains varies with time as $S(\tau) \sim \exp(-\alpha/\tau)$, ere α is a constant whose magnitude depends on the applied stress. L.E.Cross

539.2 : 537.2 : 539.3

AN ALTERNATIVE TRANSFORMATION FOR THE PIEZO- ECTRIC CONSTANTS OF ANISOTROPIC MEDIA. See str. 6290

539.2 : 537.2 : 538.2

$GeFeO_3$: A FERROMAGNETIC-PIEZOELECTRIC COMPOUND. Abstr. 11825

OPTICAL PROPERTIES OF SOLIDS

539.2 : 535

13665 FUNDAMENTAL LATTICE DISPERSION FREQUENCIES OF NaCl AND KCl AT 82°K. M.Hass.

Phys. Rev., Vol. 119, No. 2, 633-5 (July 15, 1960).

The infrared dispersion frequencies of NaCl and KCl at 82°K were measured by infrared absorption of thin films and were found to be $170 \pm 2\,\mathrm{cm}^{-1}$ and $149 \pm 2\,\mathrm{cm}^{-1}$, respectively. These values can be compared with those predicted by formulae of Szigeti, Odelevski, Lundqvist, and others relating the dispersion frequency to the elastic and dielectric constants. Good agreement seems to be obtained using the Szigeti formula or a combination of the Lundqvist and Odelevski formulae at low temperatures where anharmonic effects are small.

539.2 : 535

13666 EFFECT OF HEAT ON THE COLORATION OF THE PLEOCHROIC HALOES IN BIOTITE. S.Deutsch.

Nuovo Cimento, Vol. 16, No. 2, 269-73 (April 16, 1960). In French.

The stability of pleochroic haloes in biotites heated in air and in nitrogen has been studied. The haloes can be erased by the heating process; the rate of this phenomenon increases with temperature and is greater in air than in nitrogen. A comparative study of the behaviour of haloes in different minerals would yield information on the thermal history of rocks.

539.2 : 535

13667 OPTICAL PROPERTIES OF BISMUTH. H.D.Mallon and I.G.Runciman.

Nature (London), Vol. 186, 709-10 (May 28, 1960).

Bismuth single crystals (of 99.99% purity), prepared by controlled solidification from a capillary tube and machined flat and electropolished, were orientated by means of the polarizing microscope. The reflectivities at three wavelengths (4860, 5890 and 6560 A) are given (checked by X-ray back reflection) together with ratios calculated from analyser rotations, the data being compared with values calculated from optical constants. It is shown that measurement of the analyser rotation angle provides a rapid method of determining the tilt of the optic axis ([0001] on hexagonal indexing, [111] on both rhombohedral descriptions) to an accuracy of ~ ±5°, and that the method can also be used with polycrystalline samples even if the grain size is small. H.H.Hodgson

539.2 : 535

13668 OPTICAL CONSTANTS OF THIN GERMANIUM FILMS. F.Lukeš.

Czech. J. Phys., Vol. 10, No. 1, 59-65 (1960).

The films were obtained by vacuum evaporating Ge on to glass slides. The constants were studied in the spectral ranges 0.35 to 0.78 μ for the index of absorption k and 0.35-2.5 μ for the refractive index n. The results are compared with the values obtained by other authors and with the values of n and k for single crystals. It is shown that these values for thin films and single crystals slightly differ quantitatively but agree fairly well qualitatively.

539.2 : 535

13669 A CALCULATION OF THE OPTICAL CONSTANTS OF NOBLE METALS. M.Suffczynski and S.Michaelson.

Proc. Phys. Soc., Vol. 75, Pt 5, 602-6 (May 1, 1960).

Suffczynski's previous work (Abstr. 10266 of 1959) was extended to more general band models. The extinction coefficient k and the refractive index were expressed in terms of certain integrals which have been evaluated numerically in the case of Cu for wavelengths λ from 0.05 to 3 μ and for different band parameters. Qualitative agreement with Schulz's experimental data (Abstr. 7025 of 1957) was obtained. It was concluded that the dip in the k/λ curve can be explained by the Fermi surface running close to the zone boundary without touching it, although a very small contact might not be excluded. D.M.Edwards

539.2 : 535 : 539.2 : 537.311

OPTICAL PROPERTIES OF GLASSES BASED ON THE CHALCOGENIDES OF THALLIUM, ARSENIC AND ANTIMONY. See Abstr. 13609

539.2 : 535

13670 OPTICAL AND MICROWAVE-OPTICAL EXPERIMENTS IN RUBY. T.H.Maiman.

Phys. Rev. Letters, Vol. 4, No. 11, 564-6 (June 1, 1960).

Depletion of ground state population in the Cr^{3+} centres of ruby due to absorption of light is detected by a fall in the microwave resonance associated with this state. Depletion is also observed as a decrease in optical absorption. The restoration of the normal resonance signal follows a time variation correlating with that of luminescence transitions to the ground state. G.F.J.Garlick

539.2 : 535 : 537.312

13671 OPTICAL AND PHOTO-ELECTRIC PROPERTIES OF ZINC SELENIDE AND TELLURIDE. G.A.Zholkevich.
Fiz. tverdogo Tela. Vol. 2, No. 6, 1115-17 (June, 1960). In Russian.

Describes the preparation of crystalline layers of zinc selenide and zinc telluride and subsequent measurement of spectral properties. These include spectral absorption and photo-conductivity over the wavelength range 400-800 millimicrons. T.Mulvey

539.2 : 535

13672 SURFACES OF REFRACTION AND ABSORPTION OF ABSORBENT MONOCLINIC AND TRICLINIC CRYSTALS. A.M.Goncharenko.
Kristallografiya, Vol. 4, No. 3, 393-8 (May-June, 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 3, 365-70 (March, 1960).

The invariant method is employed in considering the form of plane sections of the surfaces of refraction and absorption of absorbent monoclinic and triclinic crystals. In addition to the general case, the case of crystals of lower order with one optical axis is also studied. Section curves are plotted for crystals having parameters of intermediate value.

539.2 : 535.

13673 SURFACES OF REFRACTION AND ABSORPTION OF ABSORBING CRYSTALS.
A.M.Goncharenko and F.I.Fedorov.
Kristallografiya, Vol. 3, No. 5, 587-92 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 5, 592-8 (Dec., 1959).

Cross-sections in the principal planes of the surfaces of the refractive indices and absorption coefficients of crystals of the orthorhombic and middle systems are examined. A simple universal graphic method is given for determining the extremal directions of the refractive indices and absorption coefficients in these sections.

539.2 : 535

13674 CONCERNING SOME PECULIARITIES OF THE BEHAVIOUR OF THE INDICES OF REFRACTION AND THE COEFFICIENTS OF ABSORPTION OF ABSORBING CRYSTALS.
A.M.Goncharenko.
Kristallografiya, Vol. 4, No. 5, 727-31 (Sept.-Oct., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 588-92 (May, 1960).

The problem of the coincidence of the indices of refraction and the coefficients of absorption of both isonormal waves in absorbing crystals is investigated by the use of the method of invariants. It is shown that the corresponding directions of the wave normals form the surface of a cone of the 24th order. Some characteristics of that cone are investigated, and examples of strongly absorbing crystals in the orthorhombic, monoclinic and triclinic systems are presented

539.2 : 535

13675 OPTICAL FARADAY ROTATION IN FERRIMAGNETIC GARNETS. A.M.Clogston.
J. Phys. Radium, Vol. 20, No. 2-3, 151-4 (Feb.-March, 1959). In French.

The transitions involved are both spin and parity forbidden. A non-zero transition probability arises from the combined action of spin—orbit coupling, and lattice vibrations which augment the ground and excited states with odd-parity angular momentum states. These states are split in the presence of the exchange field by spin—orbit coupling and lead to Faraday rotation. The ratio of rotation to absorption is calculated and found to give satisfactory agreement with experiment.

539.2 : 535

13676 OPTICAL ABSORPTIONS AND ROTATIONS IN THE FERRIMAGNETIC GARNETS. J.F.Dillon, Jr.
J. Phys. Radium, Vol. 20, No. 2-3, 374-7 (Feb.-March, 1959).

The optical properties of several of the ferrimagnetic garnets have been measured. There are several maxima in the absorption below an absorption edge at about 5200 A. Light passing through the crystals undergoes a nonreciprocal rotation of its plane of polarization. The structure in the plot of rotation versus photon energy reflects that in the absorption curve. A magnetic circular dichroism is observed. These data allow the electronic energy levels in these magnetic materials to be studied. The properties are such that domain structure can easily be seen and studied by transmitted light.

539.2 : 5

13677 THE FARADAY EFFECT IN YTTRIUM GARNET AT INFRARED FREQUENCIES.
G.S.Krinchik and M.V.Chetkin.
Zh. eksper. teor. Fiz., Vol. 38, No. 5, 1643-4 (May, 1960). In Russian.

A brief report, with a graph, of the results of measurements the Faraday effect in a plate of the ferrite yttrium garnet, Y_3Fe_5O over the infrared range $0.94\,\mu < \lambda < 9.0\,\mu$. The abscissae of the gr are wavelengths, the ordinates are angles of rotation of the plane polarization θ. From $\lambda \sim 1\mu$ to $\sim 7\mu$, where phonon absorption begins, θ is nearly constant. Just below $\lambda \sim 1\mu$, near the edge of t electron absorption band, θ falls sharply as λ decreases. On the same diagram, two other curves show the Faraday effect in non-ferromagnetic glass and rocksalt. The surmise that in non-ferro magnetic semiconductors electron transitions are mainly respons for the rotation of the plane of polarization, is acceptable since it predicts that $\theta \propto \lambda^{-2}$, in accordance with experiment. N.D

539.2 :

13678 ADDITIONAL ANOMALOUS LIGHT WAVES IN ANTH CENE IN THE REGION OF EXCITON ABSORPTION.
M.S.Brodin and S.I.Pekar.
Zh. eksper. teor. Fiz., Vol. 38, No. 6, 1910-12 (June, 1960). In Russian.

Working at a frequency of 25 108 cm^{-1} and at 20°K, the autho repeated their previous measurements on the intensity of light transmitted through thin anthracene films. Greater precautions were taken to exclude double refraction effects. An oscillatory variation of intensity with thickness was observed, the period bei 0.058 μ. M.G.Priest

539.2 :

13679 EXCITONS AND THE ABSORPTION EDGE OF CADM SULFIDE. D.G.Thomas, J.J.Hopfield and M.Power.
Phys. Rev., Vol. 119, No. 2, 570-4 (July 15, 1960).

The absorption coefficient between 10 and 300 cm^{-1} was mea ured for crystals of CdS in polarized light between 20 and 300°K, wavelengths near 5000 A. Analysis of the results at various tem tures near 70°K shows that the absorption is in agreement with th calculated for a process involving the simultaneous creation of a exciton and the absorption of a phonon, both particles having a sm wave vector. This agreement is strong evidence that the conduct band minimum and the valence band maximum in CdS both occur a the centre of the Brillouin zone.

539.2 :

13680 OPTICAL ANISOTROPY OF CUBIC CRYSTALS CAUS BY THE PHENOMENON OF SPACE DISPERSION. QUADRUPOLE EXCITON ABSORPTION OF LIGHT IN CUPROUS OXIDE. E.F.Gross and A.A.Kaplyanskii.
Dokl. Akad. Nauk SSSR, Vol. 132, No. 1, 98-101 (May 1, 1960). In Russian.

Observations on single Cu_2O crystals, with light (λ = 6125 A) propagated in the direction of the 2-, 3- and 4-fold axes shows th the absorption is anisotropic, and it is suggested that this is due quadrupole transitions. R.F.S.Hearn

539.2 :

13681 DISPERSION OF LIGHT IN THE EXCITON ABSORPT REGION OF CUBIC CRYSTALS TAKING ACCOUNT O THE ANISOTROPY IN EFFECTIVE MASS OF THE EXCITON.
S.I.Pekar and B.E.Tsekvava.
Fiz. tverdogo Tela, Vol. 2, No. 2, 261-72 (Feb., 1960). In Russia

This is an extension of work reported previously (Abstr. 515 1958, 1857 of 1959 and 1730 of 1960) but the anisotropy of effectiv mass is considered. Figures show the dispersion curves for defi values of the relevant parameters for the four indices of refracti (a) when the effective masses in two perpendicular exciton bands different (which is to be expected when its K is in any direction other than (001) and (111) or their equivalents); and (b) for K alon these directions. The possibility of separating out the various wa experimentally is discussed. R.Bern

539.2 : 535 : 537.311

13682 ABSORPTION OF INFRARED RADIATION BY SEMICONDUCTORS IN AN ELECTRIC FIELD. N.V.Fomin.

. tverdogo Tela, Vol. 2, No. 4, 605-7 (April, 1960). In Russian.

Examines the dependence of the absorption of infrared radiation the current carriers in non-degenerate semiconductors on the le between the direction of polarization of the light and the ection of the electric field. It is shown that for $eEl \ll kT$ (where s the field, l the mean free path of the current carriers) the ect is a quadratic function of the field. W.Bardsley

539.2 : 535

13683 OPTICAL ABSORPTION BY DEGENERATE GERMANIUM. J.I.Pankove.

ys. Rev. Letters, Vol. 4, No. 9, 454-5 (May 1, 1960).

In previous work (Abstr. 2879 of 1960), degeneracy due to purities in germanium was held to result in an effective shrink- e of the energy gap. Curves for the optical transmission of fers of germanium doped with a known concentration of arsenic now recorded both for a Cary double-beam spectrometer using artz optics and for the Perkin Elmer Model 112 with NaCl prism, indicate how doping moves the valley of the conduction band to ower energy. A judicious plot of the transmission data is ployed to separate the effect of free carrier absorption. The dence shows that for germanium, unlike InSb, the shrinkage of energy gap is greater than the rise of the Fermi level.
H.H.Hodgson

539.2 : 535

13684 INFRARED ABSORPTION AND VALENCE BAND IN INDIUM ANTIMONIDE. G W.Gobeli and H.V.Fan.

ys. Rev., Vol. 119, No. 2, 613-20 (July 15, 1960).

Infrared absorption is studied at near liquid helium tempera- re from n- and p-type degenerate samples of various carrier ncentrations. The absorption in p-type samples, at photon energies rger than the energy gap, depends on the hole concentration. The sults show that the valence band is warped and that the energy at 0 is very close to the maximum energy of the band. A step in the sorption of n-type samples is observed which gives an estimate ~0.012 m for the effective mass of light holes. The long wave- gth absorption in p-type samples is characteristic of inter- ence band transitions.

539.2 : 535 : 537.311

13685 INVESTIGATION OF THE ACCURACY OF THE VARIATIONAL METHOD IN THE PROBLEM OF PURITY ABSORPTION OF LIGHT IN SILICON.

I.Buimistrov and U.N.Piskovoi.

. tverdogo Tela, Vol. 2, No. 4, 608-10 (April, 1960). In Russian.

Shows that the precision of the variational calculations of the rgy terms of optical electrons from the addition of group V purities in Si is no better than several per cent. W.Bardsley

539.2 : 535

3686 ULTRAVIOLET TRANSMISSION OF DIHYDROGEN ARSENATE AND PHOSPHATE CRYSTALS.

J.Deshotels.

Opt. Soc. Amer., Vol. 50, No. 9, 865 (Sept., 1960).

Ultraviolet transmission curves for propagation parallel to the ic axis of the dihydrogen arsenates and phosphates of ammonium d potassium show that these crystals are transparent to at least 0 mμ. Application of the crystals as electro-optical shutters is cussed.

539.2 : 535.33

3687 THE EFFECT OF ABSORBANCE ON RAMAN INTENSITIES IN SOLIDS. F.Vratny and R.B.Fischer.

pl. Spectrosc., Vol. 14, No. 3, 76-8 (June, 1960).

Raman spectra have been observed for several simple systems powders in the solid state. The (measured) intensities of the man bands appear to be functions which are dependent upon the ncentration and the particle size of the Raman scattering material. significant effect on the Raman intensity was noted as a result the "effective absorptivity" of the material, defined as the com- ed effect of absorbance and the scattering of the material. mple thickness and materials of high, low and intermediate ective absorptivity are considered to demonstrate their effects the Raman intensities.

539.2 : 535.33 : 532.7

13688 THE RAMAN SPECTRUM OF ANTIMONY TRIBROMIDE. J.C.Evans.

J. molecular Spectrosc., Vol. 4, No. 5, 435-8 (May, 1960).

The Raman spectra of antimony tribromide in the solid phase, the liquid phase and in CS_2 and CCl_4 solutions are reported. Depolarization measurements enabled the frequency assignment to be made, and the force constants of a four-constant potential function were calculated using the frequencies observed in CCl_4 solution. The data offer no explanation for some unexplained features in the infrared spectrum.

539.2 : 535.33

13689 POLARIZATION STUDIES ON THE RAMAN SPECTRA OF CUBIC CRYSTALS. I. SODIUM CHLORATE.

V.Ananthanarayanan.

Z. Phys., Vol. 159, No. 1, 51-62 (1960).

Expressions are worked out for the polarization of the Raman lines as a function of the angle β between the crystal axes and the normal to the scattering plane. For unpolarized incident radiation and with $\beta = 22\frac{1}{2}^{\circ}$ the ratio ρ of the two components of polarization in the scattered beam should be 1 for totally symmetric A lines, > 1 for doubly degenerate E lines and < 1 for triply degenerate F lines. The method is tested with sodium chlorate, for which a thin crystal must be used to minimize the effect of optical rotation. Satisfactory classification of the lines is obtained, although the finite convergence of the beam modifies the actual ρ values.
G.F.Lothian

539.2 : 535.33

13690 INFRARED STUDIES OF CRYSTAL BENZENE. II. RELATIVE INTENSITIES.

C.A.Swenson and W.B.Person.

J. chem. Phys., Vol. 33, No. 1, 56-64 (July, 1960).

For Pt I, see Abstr. 2939 of 1960. Intensities of the absorption bands observed with a thin sample of polycrystalline benzene were measured relative to the absorption of ν_{20} at 1036 cm^{-1}. The gas-phase-allowed fundamentals are much the strongest bands in the spectrum. The relative intensities of these fundamentals are considerably different from the relative intensities in the gas or liquid phase. The experimental errors are discussed in detail with the conclusion that the observed difference in relative intensities are well outside any conceivable experimental errors. As a result, it is concluded that existing theories of spectra in condensed phases must be modified to predict different behaviour for each fundamental vibration. Finally, attention is drawn towards some of the anomalies still existing in the assignment of vibrational frequencies in the benzene molecule.

539.2 : 535.33

13691 INFRARED STUDIES OF CRYSTAL BENZENE. IV. ABSOLUTE INTENSITIES.

W.B.Person and C.A.Swenson.

J. chem. Phys., Vol. 33, No. 1, 233-6 (July, 1960).

For Pt III, see Abstr. 8003 of 1960. The intensity of the absorption due to ν_{20} at 1036 cm^{-1} in solid benzene at -170°C was measured relative to the intensity of this band measured with the same benzene film in the liquid phase at 25°C, From this ratio and from the value for the absolute intensity of ν_{20} in liquid benzene reported by Hisatsune and Jayadevappa, a value of 670 ± 90 darks for the absolute intensity of ν_{20} in solid benzene is obtained. Using the relative intensity measurements reported earlier, the absolute intensities of all the gas-phase-allowed fundamentals have been estimated. All the intensities in the crystal are lower than the values in the liquid phase, but the behaviour of the bands at 1036 and 1480 cm^{-1} is not too abnormal. However, the intensities of the fundamentals at 687 and 3060 cm^{-1} decrease markedly from the gas-phase values, the former by a factor greater than two, the latter by a factor of seven. Thus, it is concluded that the interaction in the solid which cause the intensity to change are quite specifically limited to these two normal modes. Analysis of the data using the isotope intensity sum rules modified for use with crystals reveals that the intensity changes observed are much greater than those expected due to simple distortion of the normal coordinates by the crystal field.

539.2 : 535.33

13692 FINE STRUCTURE OF THE FUNDAMENTAL ABSORPTION EDGE OF SINGLE CRYSTALS OF CADMIUM SELENIDE. E.F.Gross and V.V.Sobolev.

Fiz. tverdogo Tela, Vol. 2, No. 3, 406-13 (March, 1960). In Russian.

Reports on investigation of the line-type structure of the absorption and reflection spectra at 77.3°K and 4.2°K using non-polarized and polarized light. A comparison was made with the similar spectra of the isomorphic CdS and analogies were found.

W.Bardsley

539.2 : 535.33 : 532.7

13693 ABSORPTION SPECTRA OF CRYSTALS AND SOLUTIONS OF Fe, Ni AND Cu MONO-, DI- AND TRI-ETHANOLAMINE COMPLEXES.

B.G.Gasanov and S.V.Grum-Grzhimailo.

Kristallografiya, Vol. 4, No. 5, 732-41 (Sept. - Oct., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 693-701 (May, 1960).

The spectra of these complexes are measured in the region 300-1100 mμ and show generally an absorption maximum near 600 mμ. In addition, refractive index values and dichroic properties of the crystals are reported.

G.F.Lothian

539.2 : 535.33

13694 INTER- AND INTRAMOLECULAR POTENTIALS AND THE SPECTRUM OF ICE. C.Haas and D.F.Hornig.

J. chem. Phys., Vol. 32, No. 6, 1763-9 (June, 1960).

Whereas the spectra of H_2O and D_2O ice cannot yet be explained unambiguously, the spectra of HDO in dilute solution in either H_2O or D_2O may be interpreted readily. In particular, since ν_{OH} occurs at 3275 cm^{-1} and 2 ν_{OH} at 6300 cm^{-1}, nearly the harmonic value, the barrier to proton transfer lies well above the latter level and must exceed 23 kcal/mole. The width of ν_{OD} at 2416 cm^{-1} is only 20 cm^{-1}, whereas that of ν_{OH} is about 80 cm^{-1} and 2 ν_{OH} about 600 cm^{-1}. These widths can be explained by proton tunnelling if the barrier height is near 32 kcal, in which case the second minimum must lie below the level ν_{OH}. It must therefore be less than 14 kcal/mole above the primary minimum. A doubling of ν_{OD} from OD...OD pairs was also observed and the magnitude of the splitting is consistent with an effective charge of 0.6e on the protons. It is clear from these results that the usual width of hydrogen bonded OH lines is not an intrinsic characteristic of the O—H...O bond but results largely from intramolecular coupling of the O—H motions.

539.2 : 535.33

13695 ABSORPTION SPECTRUM OF MANGANOUS HALIDES TETRAHYDRATES IN THE ANTIFERROMAGNETIC STATES. I.Tsujikawa and E.Kanda.

J. Phys. Radium, Vol. 20, No. 2-3, 352-4 (Feb.-March, 1959).

The absorption spectrum of $MnCl_2.4H_2O$ and $MnBr_2.4H_2O$ has been observed between 20 and 1.2°K in order to study the antiferromagnetic states spectroscopically. The molecular fields which are deduced from the measurements of wave number as a function of temperature and of spectral polarization as a function of field are in good agreement with Henry's results. The preferred direction for the two salts is found to be the c-axis or near to the c-axis. The critical field is between 2500 and 5000 Oe for $MnCl_2.4H_2O$ and between 7500 and 10 000 Oe for $MnBr_2.4H_2O$ at 1.2°K, respectively.

539.2 : 535.33

13696 ABSORPTION SPECTRA OF SOLID METHANE, AMMONIA, AND ICE IN THE VACUUM ULTRAVIOLET.

K.Dressler and O.Schnepp.

J. chem. Phys., Vol. 33, No.1, 270-4 (July, 1960).

The vacuum u.v. spectra of solid ammonia and ice are found to be shifted to higher frequencies relative to the corresponding vapour spectra by 7000 cm^{-1}. The effects of hydrogen bonding in the ground states of these solids, and the nature of repulsive interactions possible in the excited states are discussed. In methane, which forms a pure van der Waals solid, the spectra of gas and solid are found to be very similar.

539.2 : 535.33 : 538.27

OPTICAL SPECTRA OF YTTERBIUM IN THE CUBIC FIELD OF CALCIUM FLUORIDE. See Abstr. 11938

539.2 : 535.33

13697 VIBRATIONAL SPECTRA OF CRYSTALLINE n-PARAFFINS. I. METHYLENE ROCKING AND WAGGING MODES. R.G.Snyder.

J. molecular Spectrosc., Vol. 4, No. 5, 411-34 (May, 1960).

Infrared spectra of crystalline n-paraffins from n-$C_{20}H_{42}$ through n-$C_{30}H_{62}$ are reported. It is found that to an excellent approximation, the frequencies of methylene rocking and wagging modes are a function of a single parameter. This parameter is related to the phase difference, φ, in the motion between two adjacent methylene groups of a given chain. From the infrared frequencies, explicit equations have been derived which give methyle rocking and wagging frequencies as a function of φ. Extrapolatio to infinite chain length indicates some revisions in earlier infrar and Raman assignments in the vibrational spectrum of polyethyle

539.2 : 535

13698 ELECTRONIC TRANSITIONS OF RARE EARTH IONS IN THE INFRARED REGION.

G.Mandel, R.P.Bauman and E.Banks.

J. chem. Phys., Vol. 33, No. 1, 192-3 (July, 1960).

The $^2F_{7/2} \leftarrow {^2F_{5/2}}$ transition of the cerous ion was observed ir solid solutions of cerium (III) fluoride in cadmium fluoride. The band centre is at about 2250 cm^{-1}, in good agreement with the fre ion value of 2253.0 cm^{-1}. The crystal field splitting of the band appears to be enhanced by the effect of the interstitial fluoride io which compensate for the excess positive charge of Ce^{3+} in Cd^{2+} positions. Addition of NaF, which eliminates the interstitial fluo ions, decreases the splitting. Praseodymium and neodymium ion in CdF_2 also showed absorption bands.

539.2 : 535

13699 ABSORPTION SPECTRA OF SOLID XENON, KRYPTC AND ARGON IN THE VACUUM ULTRAVIOLET.

O.Schnepp and K.Dressler.

J. chem. Phys., Vol. 33, No. 1, 49-55 (July, 1960).

The absorption spectra of solid xenon, krypton and argon at 4.2°K were investigated between 3500 and 1200 A. In the region between 1510 and 1200 A solid xenon has four absorption bands, three of which lie within less than 800 cm^{-1} of atomic transitions all being shifted to lower energy in the solid. Solid krypton has two bands between 1250 and 1200 A which lie within 900 cm^{-1} of atomic transitions but are shifted to higher energy in the solid. N absorption was found in solid argon at wavelengths longer than 1200 A. The experimental results are interpreted and discussed the basis of valence type interatomic interactions in the excited states. It is predicted that the fluorescence spectra of these soli would be displaced to lower energy by about 1 eV.

539.2 : 535

13700 INVESTIGATION OF THE ABSORPTION SPECTRA O ZINC SULPHIDE CRYSTALS.

E.F.Gross, L.G.Suslina and K.F.Komarovskikh.

Optika i Spektrosk., Vol. 8, No. 4, 516-20 (April, 1960). In Russi

Polarization of the line structure of the absorption edge of hexagonal ZnS monocrystals was measured at 4.2 and 77°K, and t absorption spectra of sublimated polycrystalline ZnS films were recorded. The nature of polarization of the spectrum of ZnS mor crystals was similar to polarization observed in other uniaxial crystals with discrete structure of the absorption edge. Thin crystals (~ 0.1μ) were found to stick to the base and the consequ deformation produced displacement and broadening of the absorpt lines. The positions and widths of the lines in the absorption spe of polycrystalline ZnS films were close to the positions and widtl of hexagonal ZnS monocrystals stuck to their bases; it follows th the films have hexagonal structure.

A.Tybulew

539.2 : 53

13701 QUANTUM YIELD FOR ENERGY TRANSFER BY RESONANCE. A.Ore.

J. chem. Phys., Vol. 33, No. 1, 31-4 (July, 1960).

The theoretical prediction of quantum yields for electric dipole—dipole energy transfer by resonance is discussed. The common approximation which neglects transfers from each dono to all but the nearest acceptor is extended so as to include trans to the second-nearest acceptor and, in the limit of very high acceptor concentration, to the third and fourth as well. The total quantum yield and the fractional yields due to transfers to the individual categories of nearest acceptors are evaluated, and the merits of the various approximations are discussed quantitativel

539.2 : 53

13702 SCINTILLATION THEORY.

Nucleonics, Vol. 18, No. 5, 86-7 (May, 1960).

A review of several papers presented at the 1960 Scintillati Counter Symposium in Washington. Meyer and Murray have calculated the response of alkali halide crystals using a model including the combination of hole—electron pairs into excitons, w diffuse and excite activators which then decay radiatively. Thei calculated curve of scintillation efficiency versus energy loss agrees very well with the experimental results. Birks and Buck presented summaries of present theories of the mode of action ganic scintillators. These seek to explain the division of energy :ween the fast and slow components of the fluorescence. These ·ories differ in the amount of light assumed to arise from excited lecules and from ionized molecules. R.D.Smith

539.2 : 535.37

13703 LUMINESCENCE OF AgCl CRYSTALS.

K.Vacek.

ech. J. Phys., Vol. 10, No. 1, 66-73 (1960). In Russian.

The luminescence of normal and deformed single crystals of ferent thicknesses was measured at −180°C. With deformed mples, the decrease in intensity of the luminescence was measured. the luminescence band of the above crystals a fine structure s observed for which the series rule could be used (edge of ries, $\lambda'_\infty = 4640$ A, $\lambda''_\infty = 5080$ A). The observed luminescence s explained by means of the exciton mechanism proposed by ityas, i.e. annihilation of a localized exciton either on a cation cancy or on a cation vacancy on a dislocation jog. The luminence yield at −183°C, $\varphi = 1.6 \times 10^{-3} \pm 10\%$ was measured by a otographic method.

539.2 : 535.37

13704 FLUORESCENCE AND PHOSPHORESCENCE OF CADMIUM IODIDE.

Monod-Herzen, Nguyen-Chung-Tu and A.t'Kint de Roodenbeck.

R.Acad. Sci. (Paris), Vol. 250, No. 22. 3618-19 (May 30, 1960). French.

Under long ultraviolet pure CdI_2 shows yellow-green fluorescnce at liquid air temperature, with a band peak at 5670 A. The ow curve after this excitation has a single peak at ~120°K. The mmercial salt, containing traces of Pb, has a fluorescent band ak at 5500 A at room temperature. S.T.Henderson

539.2 : 535.37

13705 LUMINESCENT PROPERTIES OF CAESIUM IODIDE CRYSTALS GROWN FROM SUPERHEATED MELT.

.A.Tsirlin, V.I.Startsev and L.M.Soifer.

tika i Spektrosk., Vol. 8, No. 4, 537-40 (April, 1960). In Russian.

CsI crystals of various degrees of purity were placed in carely cleaned evacuated and sealed quartz ampoules. They were elted there and superheated for up to 5 hours at 900°C. Next, the elts were cooled and new crystals were grown. The relative scintillation yields showed clearly that luminescence produced by perheating cannot be due to thallium impurities, but it is probably used by dissolution of quartz ampoules and consequent activation CsI with silicon. A.Tybulewicz

539.2 : 535.37

13706 EMISSION SPECTRA OF ERBIUM IN THE SCHEELITE STRUCTURE.

L.G.Van Uitert and R.R.Soden.

chem. Phys., Vol. 33, No. 2, 567-70 (Aug., 1960).

Erbium exhibits luminescent emission from excited states at 300, 18 400 and 24 500 cm^{-1} in calcium tungstate at room temperare and at 77°K. At room temperature, emission from thermally cited states at 18 830, 19 080, and 19 200 cm^{-1} is also prominent high erbium concentrations, the above spectra are essentially enched at room temperature and new spectral lines which appear originate from electronic levels just below the 18 400 and 500 cm^{-1} states are seen. However, at 77°K, emission from the 300, 18 400 and 24 500 cm^{-1} states is again strong and emission sociated with levels just below these is no longer observed. ere is no evidence of exchange coupling preferentially quenching higher-energy emission states as in the cases of Tb^{3+} and Eu^{3+}. is and the temperature dependencies observed suggest that thermal upling to the lattice is the main factor responsible for quenching emission of $Na_{0.5}Er_{0.5}WO_4$.

539.2 : 535.37

13707 THE LUMINESCENCE SPECTRA OF DIAMONDS.

G.O.Gomon.

tika i Spektrosk., Vol. 8, No. 4, 521-4 (April, 1960). In Russian.

The luminescence spectra of a large number of diamonds from rious localities in the Soviet Union were recorded between 4000 d 6600 A at 80°K. The observed differences were due to variations the absolute and relative intensities of the blue and yellow-green mponents of luminescence. The structure of the blue component s the same in all diamonds. Considerable variations of the llow-green band structure from sample to sample showed that yellow-green centres are sensitive to impurities and/or lattice fects. A.Tybulewicz

539.2 : 535.37

13708 P—N LUMINESCENCE AND PHOTOVOLTAIC EFFECTS IN GaP.

H.G.Grimmeiss and H.Koelmans.

Philips Res. Rep., Vol. 15, No. 3, 290-304 (June, 1960).

GaP crystals were prepared from the elements. Crystals made at low phosphorus pressure mainly showed n-conductivity with an activation energy of 0.07 eV. Crystals with p-conductivity were obtained by heating at high phosphorus pressure (activation energy 0.19 eV) or by doping with Zn. The non-doped crystals showed electroluminescence in bands at 6250 and 5650 A. The electroluminescence is shown to be due to the recombination of charge carriers, within p—n junctions via levels within the forbidden gap. A level scheme for undoped GaP is proposed. The crystals showed point-contact rectification and photovoltaic effects. On measuring the photovoltage as a function of wavelength excitation bands were found at 4200 and 5600 A in non-doped crystals and at 4200 and 6000 A in Zn-doped crystals. The long-wave excitation peaks of the photovoltage are explained with a two-step mechanism, one optical and one thermal.

539.2 : 535.37

13709 EXCITATION AND HIGH-TEMPERATURE ABSORPTION OF KCl : Tl.

D.A.Patterson.

Phys. Rev., Vol. 119, No. 3, 962-7 (Aug. 1, 1960).

Optical measurements were made on crystals of KCl with a wide range of thallium concentrations. Absorption was measured up to 560°C and excitation spectra for luminescence were measured from liquid nitrogen temperature to 100°C. These measurements, in conjunction with earlier work, lead to the conclusion that there are at least seven bands in KCl : Tl : three in the "A" band region and two each in the "B" and "C" band regions. The large shift from "C" band to "B" band at high temperatures which has been previously reported was not found by the author. It is noted that the addition of small amounts of Sr to KCl shifts the fundamental absorption edge to short wavelengths.

539.2 : 535.37

13710 LUMINESCENCE OF Pb- AND Pb—Mn-ACTIVATED LANTHANUM SILICATES

W.L.Wanmaker, W.P.de Graaf and H.L Spier.

Physica, Vol. 25, No. 11, 1125-30 (Nov., 1959).

Lanthanum silicates of the composition $1La_2O_3.1SiO_2$ and activated with Pb give under 2537 A excitation an u.v. emission (peak wave length 3150 A) and activated with Pb and Mn an orange emission (peak wave length 5950 A). The preparation of some lanthanum silicates is described and X-ray diagrams are given (namely $2La_2O_3SiO_2$; $La_2O_3.SiO_2$ and $La_2O_3.2SiO_2$).

539.2 : 535.37

13711 LUMINESCENCE OF SOLID NITROGEN (4.2°K) CONTAINING ATOMS OR FREE RADICALS. THE EFFECT OF TRACES OF OXYGEN, HYDROGEN AND WATER VAPOUR.

H.P.Broida and M.Peyron.

J. Phys. Radium, Vol. 19, No. 4, 480-4 (April, 1958). In French.

The influence of traces of oxygen on the solid nitrogen spectrum has led to the β-lines being attributed to atomic oxygen (transition $^1S-^1D$). Small quantities of hydrogen and water vapour have no important effect. Satellite lines, lying on each side of the α-line (atomic nitrogen transition $^2D-^4S$) and the β-lines, as well as being related to the respective atoms are also related to the nitrogen molecule. The possibility of vibrational energy exchanges in the solid is discussed.

539.2 : 535.37

13712 THE TEMPERATURE DEPENDENCE OF LUMINESCENCE OF NaI:Tl CRYSTALS AT TEMPERATURES OF 0-270°C.

V.I.Startsev, Z.B.Baturicheva and Yu.A.Tsirlin.

Optika i Spektrosk., Vol. 8, No. 4, 541-4 (April, 1960). In Russian.

After several heating—cooling cycles the intensity of luminescence of NaI, activated with 0.05-0.1% Tl and excited with γ-rays, was found to decrease linearly with a rise of temperature at the rate of 0.12 ± 0.03% per degree. Luminescent properties of the crystals were not affected by the amount of thallium between 0.05 and 0.1%. At room temperature the main component of luminescence, amounting to 90-95% of the total signal, had a decay time of 0.25 μsec; the remaining 5-10% of luminescence had a decay time of 0.7-1.2 μ sec. A.Tybulewicz

539.2 : 535.37

13713 DETECTION OF THE IONIZATION OF Eu^{++} IN THE PHOSPHOR SrS:Eu,Sm BY THE METHOD OF PARAMAGNETIC ABSORPTION.

V.V.Antonov-Romanovskii, V.G.Dubinin, A.M.Prokhorov, Z.A.Trapezhikova and M.V.Fok.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1466-7 (Nov., 1959).
In Russian.

Three independent methods were used to confirm that the stimulation of the phosphor SrS:Eu,Sm arises from the ionization of the activator (Eu^{++}–Eu^{+++}). K.N.R.Taylor

539.2 : 535.37

13714 THE TWO MODIFICATIONS OF THE MIXED SYSTEMS $TlBr-NH_4Br$ AND THE PROBLEM OF Tl-CENTRES IN ALKALI HALIDE–THALLIUM PHOSPHORS. P.Brauer.

Z. Naturforsch., Vol. 15a, No. 5-6. 418-24 (May-June, 1960).
In German.

Mixed crystals of $TlBr-NH_4Br$, in which the ratio Tl/NH_4 was varied between 10^{-5} and 50, were prepared from the melt under pressure. Reflection, excitation and luminescence spectra were obtained at room temperature and between 120° and 165°C, at which the two modications of the mixed crystals were stable, depending on Tl content. The spectra of specimens of similar composition but different structure (CsCl or NaCl type) could thus be compared. At low Tl concentrations ($< 10^{-3}$) the absorption and excitation bands of the blue emission coincides, a shift of 600 cm^{-1} occurred between the two modifications. At higher Tl concentrations, the absorption and excitation bands broadened and were no longer coincident, and a green Tl emission appeared, which rapidly increased in intensity with Tl content. It is concluded that the blue emission centres are Tl^+ ions, and the green centres consist of two neighbouring Tl^+ ions. J.Franks

539.2 : 535.37

13715 EXCITATION SPECTRA OF VANADIUM-ACTIVATED ZINC AND CADMIUM SULPHIDE AND SELENIDE PHOSPHORS. G.Meijer and M.Avinor.

Philips Res. Rep., Vol. 15, No. 3, 225-37 (June, 1960).

Excitation spectra were measured for the 2 μ fluorescence band. The emission is excited by absorption in two composite bands due to vanadium at 1.1 and 1.6 eV, by absorption in an auxiliary impurity centre, such as copper or silver, if present, and by fundamental excitation.

539.2 : 535.37

13716 SELF-ACTIVATED AND Cu-ACTIVATED FLUORESCENCE OF ZnS. W. van Gool and A.P.Cleiren.

Philips Res. Rep., Vol. 15, No. 3, 238-53 (June, 1960).

Two series of experiments on the fluorescence of ZnS are described. The first one, of which only a review of the experimental results is given, presents some additional data on the theory of ZnS activated with Cu, presented by Kröger and co-workers. In the second series a limited number of phosphors have been studied. In particular, the difference between the blue Cu emission and the blue self-activated emission of ZnS has been examined. The temperature dependence of the fluorescence bands and the influence of the coactivator on both mentioned fluorescences and the green copper fluorescence were determined. The results can be interpreted by assuming that the low-temperature fluorescence is dependent on the coactivator. The room-temperature emission bands can have a composite character, in such a way that in addition to the low-temperature emission band another band may be important. The results are to some extent uncertain, due to experimental difficulties. These are discussed and it is stressed that further careful experimental work may be more important for knowledge of the ZnS fluorescence than detailed calculations about some special model.

539.2 : 535.37

13717 FLUORESCENCE OF SOME ACTIVATED ZnS PHOSPHORS. W. van Gool, A.P.Cleiren and H.J.M.Heijligers.

Philips Res. Rep., Vol. 15, No. 3, 254-74 (June, 1960).

Several series of ZnS phosphors were prepared in a H_2S atmosphere at 1150-1200°C. Activators used were Ag, Cu, Au and coactivators were Al, Sc, Ga, In. Phosphors were made with all combinations of activators and coactivators with one concentration. In other phosphors equal concentrations of selected pairs of activators and coactivators were studied at different levels. Some special series of phosphors were made in addition, and spectral distributions of all phosphors at room temperature and at –90°C are reported. The spectral distributions can be separated into parts of low and high photon energy. The high-energy parts can b attributed to the presence of the activators. The low-energy part are of a composite structure. Part of these bands is due to an associate centre of activator and coactivator. Other parts of the low-energy bands may be due to other centres, which could not be identified unambiguously.

539.2 : 535

13718 EFFECT OF HEAVY HALOGENS ON THE PROBABIL OF THE TRANSITION INTO A METASTABLE STATE AND ON THE PROBABILITIES OF DEACTIVATION OF THIS STA

V.A.Borgman, I.A.Zhmÿreva, V.V.Zelinskii and V.P.Kolobkov.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 4, 781-4 (April 1, 1960).
In Russian.

The aim of the present research was to demonstrate that the effect of the halide-type quenching agents on the fluoresence of organic compounds consists in the increase of the transition of th excited molecules into a metastable state (r), and to study the effe of these agents on the probabilities of transitions from the metast able into the ground state both without emission (q_2) and with emis (π). Unlike an earlier paper [Zelinskii and Kolobkov, Optika i Spektrosk., Vol. 1, 560 (1956)], bromides were also used besides iodides, and higher concentrations of the latter were applied. The substances tested were 7 methylphthalimide derivatives, one ami naphthalene, one naphthylamine and Michler's ketone. The result obtained bear out unequivocally the correctness of the assumptio referred to above. F.Lachn

539.2 : 535.

13719 INVESTIGATION OF AN ORGANOPHOSPHOR IN THE PREEXCITED STATE. M.Frackowiak and J.Heldt.

Acta phys. Polon., Vol. 18, No. 2, 93-106 (1959).

The phosphorescence decay curve of acridine yellow in gelati after long pre-excitation in linearly polarized light was investigat It was found that the decay constant of the luminescent group of centres increases exponentially with the pre-excitation time. An increase in the decay constants conditions the decreases in the to light of phosphorescence in the deformed (pre-excited) state. These changes are caused by the appearance, during strong pre-excitation, of unstable isomers of the dye.

539.2 : 535.

13720 SYMMETRY OF THE GREEN PHOSPHORESCENCE O HEAT PRETREATED COLORED KCl CRYSTALS.

A.Halperin and N.Lewis
Phys. Rev.,Vol.,119, No. 2, 510-15 (July 15, 1960).

On thermal pretreatment in the open air at 700° C, the phosphorescence of KCl crystals after X-ray colouring at liquid-air temperature turned from violet to green. While the former phosphorescence showed no anisotropy the green was found to become partially polarized after irradiation with [011] light. The irradiation also induced dichroic absorption at 3650 A. Both the polariza tion in the phospherescence and the dichroic absorption persisted u to nearly 200° K. The polarized light bleached the component of th 3650 A absorption in parallel to it, but enhanced the green phosph rescence with the main effect on the perpendicular component. It suggested that oxygen which diffused into the crystal during the he treatment is responsible for the asymmetric centre.

539.2 : 535

13721 THE DECAY OF PHOSPHORESCENCE IN ZINC SULPHIDE. J.Saddy.

J. Phys. Radium, Vol. 20, No. 11, 890-6 (Nov., 1959). In French.

The distribution of electron traps was studied using the law o decay of phosphorescence as a function of time. The brightness w measured over a long interval of time, and accurate analyses ma of the decay law exponentials. The trap distribution so determine well represented by a Gaussian group. The decay law results fro it by making an integral of the depth of the group, as a whole. Th integral may be represented, in practice, by an analysis of a suitable sum of exponential functions. The best analysis makes u of exponentials representing the successive contribution of traps equidistant depth, taken from within the group.

539.2 : 535

13722 ELECTRICAL PROPERTIES OF POWDERS OF ELECTROLUMINESCENT ZnS. R.Goffaux.

J. Phys. Radium, Vol. 20, Suppl. No. 4, 18A-22A (April, 1959).
In French.

The current-voltage characteristic of electroluminescent powders of zinc sulphide excited at 50 c/s is similar to that of a varistor. The effective impedance of the electroluminescent laye be represented by a variable resistance R_p connected in parallel a variable capacity C_p. An interpretation of the variation of and Cp with applied voltage has been developed on the basis of vious work on the behaviour of varistors subjected to an alter- ng potential. It appears to be in good agreement with the erimental results. The distinction between electroluminescent non-electroluminescent phosphors is suggested to be due entially to differences in free electron density and the associated sibility of an electron temperature appreciably higher than the ice temperature.

539.2 : 535.37 : 541.14

13723 CHEMILUMINESCENCE OF ETHYLENE FORMED PROBABLY FROM METHYLENE IN AN INERT MATRIX.

.Goldfarb and G.C.Pimentel.

hem. Phys., Vol. 33, No. 1, 105-8 (July, 1960).

An orange-red luminescence occurs when diazomethane pended in solid nitrogen or solid argon is photolyzed and then rmed to permit diffusion. Spectographic and visual studies of this rmoluminescence are reported here. Conditions favourable for production of the luminescence also result in relatively high lds of ethylene as a final product. Furthermore, a deuteration ct is observed. For CH_2N_2 the recorded spectrum consists of a tinct feature at 6030 A and an extremely weak feature near 6530 A. uterated diazomethane produces a spectrum with two distinct tures at 6055 and 6405 A, and one or more weaker absorptions ween 6700 and 6800 A. The emission is assigned to chemiluminesc- e of ethylene and a tentative interpretation is given in terms of excited states of ethylene (Z → V).

MAGNETIC PROPERTIES OF SOLIDS

539.2 : 538.1

13724 THE ISOLATED AND ADIABATIC SUSCEPTIBILITIES OF LARGE SYSTEMS.

W.J.Caspers.

ysica, Vol. 25, No. 8, 645-58 (Aug., 1959).

It can be shown that for large systems of magnetic ions with ole–dipole interaction, the isolated susceptibility χ_{is} and the abatic susceptibility χ_s are identical, if two hypotheses are de about the nature of the energy spectrum of such systems. ese hypotheses state that the density of energy levels of such tems and the derivative of every energy eigenvalue with respect H, the constant external field, can be approximated by continuous ctions of the energy, for a fixed value of H. The derivation of equivalence of χ_{is} and χ_s is given for single crystals for all ections of the external field with respect to the crystal axes for all values of H, whereas the ratio $\chi_{is} : \chi_s = 4 : 5$, derived a previous paper (Abstr. 6216 of 1960) for a certain class of all systems, refers to powders only and to large values of H. s shown that in the case of large H there is always a frequency erval in which the high-frequency susceptibility of a powder the value of χ_{is} (computed in the previous paper), though the gle crystals in a powder are expected to be much larger than se systems for which the computation given in that paper is rect.

539.2 : 538.1

13725 MAGNONS AND THEIR INTERACTIONS WITH PHONONS AND PHOTONS.

C.Kittel.

Phys. Radium, Vol. 20, No. 2-3, 145-7 (Feb., 1959).

A review is given of the theory of spin waves and of the principal sical effects associated with spin waves. It is shown that the ndary condition $m_x = m_y = 0$ at the surface permits the excitation spin waves by a uniform r.f. field. These excitations have been served by other workers.

539.2 : 538.1

13726 THE MAGNETIC SUSCEPTIBILITY OF A RELATIVISTIC ELECTRON GAS.

A.A.Rukhadze and V.P.Silin.

. eksper. teor. Fiz., Vol. 38, No. 2, 645-6 (Feb., 1960). In Russian.

An expression is given for the magnetic susceptibility in ms of a relativistic quantum distribution function with a given ation of motion. The expression consists of two parts with a io $-\frac{1}{3} : 1$, which correspond to the diamagnetism and the spin ramagnetism. These are evaluated for the highly degenerate rmi gas and for the limit of Boltzmann statistics.

R.B.Stinchcombe

539.2 : 538.2

13727 MAGNETIC ANISOTROPY AS A METRICAL PROPERTY OF SPACE.

L.M.Tomil'chik and F.I.Fedorov.

Kristallografiya, Vol. 4, No. 4, 498-504 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 4, 470-5 (April, 1960).

It is shown that the theory of the optical properties of homogeneous magnetic crystals can be derived from the corresponding theory for nonmagnetic crystals by introducing a metric whose tensor g is defined by the magnetic permeability tensor μ.

539.2 : 538.2

13728 MAGNETIC STUDIES AT LOW TEMPERATURE OF Cu—Co: THE EFFECT OF THERMAL AND MECHANICAL TREATMENT ON THE PRECIPITATES.

L.Weil.

J. Phys. Radium, Vol. 20, No. 2-3, 282-5 (Feb.-March, 1959). In French.

A magnetic method is used to study the texture of cobalt precipitates in copper. Cold drawing always causes rupture of the precipitated grains. Fast quenching (in an extremely rapid current of H_2) favours precipitates with particles of less than 40 A, whose size does not significantly increase with heat treatment.

539.2 : 538.2

13729 THE NATURE OF THE MAGNETIC PROPERTIES OF SIDERITE, ANKERITE AND RHODOCHROSITE.

V.M.Vinokurov.

Kristallografiya, Vol. 3, No. 5, 600-4 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 5, 606-10 (Dec., 1959).

The results of a study of the magnetic properties of siderite, ankerite and rhodochrosite are discussed. It is shown that the first two minerals are magnetically anisotropic and the latter is magnetically isotropic. An explanation of the cause of the anisotropy and isotropy of these minerals is given and the possible application of magnetic measurements for purposes of chemical analysis and identification of minerals is considered.

539.2 : 538.2

13730 THEORY OF DIAMAGNETISM OF GRAPHITE.

J.W.McClure.

Phys. Rev., Vol. 119, No. 2, 606-13 (July 15, 1960).

The conduction-electron diamagnetism is calculated for the three-dimentional band structure of graphite. The magnetic energy levels are found and the susceptibility calculated by analytically carrying out the free energy sum. Agreement with experiment is found for values of the band parameters nearly equal to those which give agreement with the de Haas—van Alphen effect and other phenomena. The value of γ_0 is found to be 2.8 ± 0.1 eV The results indicate the γ_1 is about 0.27 eV and Δ is about 0.025. The other band parameters do not have an important influence upon the value of the susceptibility. The relation to the general treatments of conduction-electron diamagnetism is also discussed.

539.2 : 538.2

13731 THE MAGNETIC SUSCEPTIBILITIES OF SOME DIAMAGNETIC ALLOYS. THE PRIMARY SOLID SOLUTIONS OF CADMIUM, INDIUM, TIN, AND ANTIMONY IN COPPER AND IN SILVER; ZINC, GALLIUM, GERMANIUM, AND ARSENIC IN SILVER; COPPER IN SILVER AND SILVER IN COPPER.

W.G.Henry and J.L.Rogers.

Canad. J. Phys., Vol. 38, No. 7, 908-26 (July, 1960).

The results of the measurements of the variation with concentration of the magnetic susceptibility in the solid solutions of the following systems are presented: copper with silver, cadmium, indium, tin and antimony as solutes; silver with copper, zinc, gallium, germanium, arsenic, cadmium, indium, tin, and antimony as solutes. The density of states for silver is calculated by using the approximation to nearly free electrons. It is found that the density of states is decreasing at an electron to atom ratio of 1.0. It is further found that the method used in an earlier paper to discuss the magnetic properties of the α-solid solutions formed with copper by zinc, gallium, germanium, and arsenic is applicable to the monovalent-polyvalent systems of the present paper. It is concluded from the magnetic measurements that the Fermi surface touches the (III) Brillouin zone foace in both silver and copper and that the rate of decrease of the density of states with electron to atom ratio is given approximately by the approximation to nearly free electrons. The solid solutions in the silver-copper system are anomalous.

539.2 : 538.2

13732 SPIN—PHONON INTERACTION IN PARAMAGNETIC CRYSTALS. R.D.Mattuck and M.W.P.Strandberg.

Phys. Rev., Vol. 119, No. 4, 1204-17 (Aug. 15, 1960).

A general theory of the spin—phonon interaction, which is applicable to any iron group spin not in an S state, is developed. The theory employs a perturbation treatment that has a more direct physical meaning than techniques previously used and that leads to more accurate results. These results are presented in the form of an equivalent spin—phonon interaction Hamiltonian involving sums over products of spin operators and phonon creation-annihilation operators. The interaction between any two spin levels can then be calculated by using the spin wave functions associated with the usual "spin Hamiltonian". It is shown that, owing to the dominant role played by the quadratic term in the above interaction, odd half-integer iron group spins ($S > \frac{1}{2}$) obey quadrupole selection rules. A formula is derived for order-of-magnitude calculations of the interaction strength. It is shown that acoustic experiments should provide the ideal way to test this theory in detail, and two methods of checking the quadrupole rule are proposed. Experimental results are reported on observed acoustic saturation in MgO doped with Cr^{3+}, on the absence of saturation between low-field Kramers doublets in ruby, and an apparent saturation effect in F-centre quartz.

539. 2 : 538.2

13733 THEORY OF ADIABATIC SUSCEPTIBILITY. T.Yamamoto.

Phys. Rev., Vol. 119, No. 2, 701-4 (July 15, 1960).

A general proof of the equivalence between χ_S and χ_{iso} is presented in the framework of statistical thermodynamics. It is based on the observation that transitions do occur during adiabatic processes due to the neglected small interactions which can hardly be included in the actual Hamiltonian. A new expression is found for χ_{iso} which is proved to coincide with χ_S and which is rederived straightforwardly from the ergodic theorem. As an example, a system of spins with a magnetic interaction under a strong magnetic field is considered by means of the perturbation method and shown to give consistent results.

539.2 : 538.2

13734 MAGNETIC DIPOLE INTERACTIONS IN DYSPROSIUM ETHYL SULPHATE. I. SUSCEPTIBILITY AND SPECIFIC HEAT BETWEEN 20 AND 1°K.

A.H.Cooke, D.T.Edmonds, F.R.McKim and W.P.Wolf.

Proc. Roy. Soc. A, Vol. 252, 246-59 (Sept. 8, 1959).

Measurements were made of the magnetic susceptibility and the magnetic contributions to the specific heat of dysprosium ethyl sulphate, at temperatures between 20° and 1°K. It is shown that below about 3°K these properties, and also the earlier optical rotation measurements of Becquerel et al., can be accounted for satisfactorily in terms of a doubly degenerate ground state of the magnetic ions, with spectroscopic splitting factors parallel and perpendicular to the crystal axis $g_{\parallel} = 10.8$ and $g_{\perp} = 0$, together with an unusually strong coupling between the ions arising from magnetic dipole—dipole interaction. The effect of other interactions is shown to be small. Because of this, and the extreme anisotropy of the g-tensor, the properties of this substance at very low temperatures ($\sim 0.1^{\circ}$K) should closely resemble those of a classical Ising model with known, dipolar forces between the ions. At temperatures above 3°K other states of the ions become populated and it is shown that the first of these lies at an energy of (23 ± 3) k, in good agreement with other experiments.

539.2 : 538.2

13735 MEASUREMENTS OF THE MAGNETIC SUSCEPTIBILITIES OF RARE EARTH GALLATES.

J.Cohen and J.Ducloz.

J. Phys. Radium, Vol. 20, No. 2-3, 402-3 (Feb.-March, 1959). In French.

The paramagnetic susceptibility of rare earth gallates of formula $5Ga_2O_3.3X_2O_3$ where X is the rare earth, was measured. The magnetic ions are under the influence of a cubic electric field which removes the degeneracy of order 2J + 1. At low temperatures only the lowest levels are occupied. The paramagnetic susceptibility does not obey a Curie law. Experimental and theoretical values agree within 3%.

539.2 : 538.2

13736 SUSCEPTIBILITY MEASUREMENTS OF [BULK] Nb BETWEEN ROOM TEMPERATURE AND LIQUID HELIUM TEMPERATURES.

A.Van Itterbeek, W.Peelaers and F.Steffens.

Appl. sci. Res. B, Vol. 8, No. 3, 177-82 (1960).

The susceptibility shows an increase of 1% per 100 degrees decreasing temperatures. No field dependence could be detected to liquid hydrogen temperature. This is in agreement with the results obtained by other authors. In the liquid He region, some anomalies appear, notwithstanding that the fields used were highe than the critical one. It is supposed that the sample was not completely in the normal state.

539.2 : 53

13737 MAGNETISM OF THE COMPOUNDS OF THE MANGA ESE—GOLD SYSTEM. A.J.P.Meyer.

J. Phys. Radium, Vol. 20, No. 2-3, 430-4 (Feb.-March, 1959). In French.

With increasing dilution of manganese, one finds that Mn_3Au shows constant paramagnetism, MnAu and $MnAu_3$ are antiferromagnetics, $MnAu_2$ is metamagnetic and $MnAu_4$ is ferromagnetic. A discussion of the magnetic states as a function of structure and interatomic distances according to the principle of direct interactions gives no satisfactory conclusions.

539.2 : 53

13738 THE MAGNETIC BEHAVIOUR OF MANGANESE- AND COBALT AMMONIUM TUTTON SALT BELOW 1°K.

A.R.Miedema, J.van den Broek, H.Postma and W.J.Huiskamp.

Physica, Vol. 25, No. 11, 1177-92 (Nov., 1959).

Adiabatic demagnetization experiments have been performed single crystals of $MnNH_4$- and $CoNH_4$- tutton salt. The susceptib in external magnetic fields and relaxation effects in zero field hav been studied. The magnetic behaviour was found to be ferromagn in the direction of the b-axis and antiferromagnetic in the plane through the other two crystals axes. The experimental results ca be explained assuming antiferromagnetic interaction only. The si of the crystal field parameter, D, is suggested to be negative in th manganese salt.

539.2 : 53

13739 A STUDY OF PARAMAGNETISM IN RARE EARTH GARNETS AT HIGH TEMPERATURES.

R.Aléonard and J.C.Barbier.

J. Phys. Radium, Vol. 20, No. 2-3, 378-81 (Feb.-March, 1959). In French.

The paramagnetic susceptibility of rare earth garnets betwee their Curie point and 1500°K was measured. The curves $(1/\chi, T)$ are respectively of the third degree and of the second degree for magnetic and non-magnetic rare-earth ions. The molecular field coefficients, which characterize the interaction between the magnetic ions, are deduced from these curves. The experimental results are in good agreement with Néel's theory of ferrites.

539.2 : 53

13740 A REPORT ON MAGNETIC RESEARCH CARRIED OU IN ITALY IN THE LAST FEW YEARS. G.Montalenti.

J. Phys. Radium, Vol. 20, No. 2-3, 208-14 (Feb.-March, 1959). In French.

A survey of the main fields of research in ferromagnetism. It has been shown that in thin films the intensities of magnetizatio at various film thicknesses are lower than the theoretical values. Some work has been done on magnetic viscosity; in particular, it was shown that there is a magnetic after-effect associated with mechanical relaxation due to grain boundary slip; the theory is in qualitative agreement with the experimental data. In the theory of hysteresis, the Preisach model has been generalized and it has b proved that all possible J—H curves for a given material can be deduced from the magnetization curve and the saturation hysteres loop. Other research was done on the Barkhausen effect. In particular, the energy spectrum of Barkhausen noise can be predicted from the shape of a single pulse; the agreement between the theor and the experimental data is satisfactory. The use of ferrites in waveguides as non-reciprocal attenuators has also been investigat

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13741 RESEARCH BY SOVIET PHYSICISTS IN THE FIELD MAGNETISM DURING RECENT YEARS.

S.V.Vonsovskij.

J. Phys. Radium, Vol. 20, No. 2-3, 264-76 (Feb.-March, 1959). In French.

In the first part, results are presented of the thermodynamic treatment of ferromagnetic transformations, based upon the theor of phase transitions of the second order (Landau method); magnet zation curve of the para-process, temperature dependence of the ıtaneous magnetization, discontinuity in the heat capacity, effect lastic stress on the magnetization curve, magnetic anomalies of 'mal expansion. The results of the thermodynamic theory of the k ferromagnetism observed in α-Fe_2O_3 (and also in NiF_2, $MnCO_3$ $CoCO_3$) are also given. In this theory, Landau's method, neutron raction data and general considerations of magneto-crystalline ımetry are used. It is shown that the weak ferromagnetism is a ılt of the perturbation of the perfect antiferromagnetic ordering ne magnetization vectors of the sublattices. This perturbation ends upon magnetic (relativistic) interactions in the crystal. In second part, the principal results of the phenomenological ıtment of the quantum-mechanical theory of ferro- and antiferro-gnetism are presented. As an example, calculations of the mag-c properties in uniaxial ferro- and antiferromagnetic crystals given. In conclusion, results obtained with the help of the (s-d) ıange model for the ferromagnetic metals and semiconductors summarized: relaxation processes at low temperatures, width he ferromagnetic resonance absorption line, g-factor of ferro-gnetic resonance in metals, electrical conductivity of ferro- and ferromagnetic metals, anomalies of electrical resistance and r properties of ferro- and antiferromagnetic metals and semi-ductors near the Curie and Néel temperatures.

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13742 REPORT OF SOME RESEARCH IN THE FIELD OF MAGNETISM AT THE PHILIPS LABORATORIES.

.G.Casimir, J.Smit, U.Enz, J.F.Fast, H.P.J.Wijn, E.W.Gorter, .W.Duyvesteyn, J.D.Fast and J.J.de Jong.

Phys. Radium, Vol. 20, No. 2-3, 360-73 (Feb.-March, 1959). In ench.

The crystalline anisotropy of a number of hexagonal oxidic npounds containing barium is discussed. In the absence of an ernal magnetic field, the magnetization vector can point in an itrary direction with respect to the c-axis. This behaviour can eady be described with two anisotropy constants. Examples are en of materials with a preferential direction (along the c-axis), h a preferential plane (basal plane) as well as with a preferential e for the magnetization vector. The latter case occurs at atively low temperatures in crystals containing cobalt. There also materials in which, at different temperatures, all three es of anisotropy occur. The relatively weak anisotropy in the al plane, which has six-fold symmetry, has been measured. crystals having only trivalent metal ions, two such ions can be laced by one divalent and one quadrivalent ion. It appears that stitution of cobalt again promotes the occurrence of a prefer-ial plane of the magnetization, as in the oxides which contain alent metal ions. The classical dipole—dipole energy has been nputed and it is shown that it can account for the observed aniso-py in the structure containing two successive barium layers, which, ıough not containing cobalt, shows a preferred plane for the gnetization vector. The anisotropy in the structure containing gle barium layers, which has a preferred direction of the magneti-ion vector, is not explained by this mechanism, and presumably ginates from spin-orbit interaction. The influence of controlled cipitation on the magnetic properties of alloys is discussed in the section. With the aid of an electron microscope, it is shown a precipitate, consisting of long parallel needles in the optimal e, causes the high $(BH)_{max}$ value (up to 12×10^6 G-Oe) of single stal "ticonal" ("alnico") containing 34% cobalt, that has under-e a special heat treatment in a magnetic field. It is further wn that a (110) [001] texture can be obtained in 3%-silicon iron y if the metal contains a precipitate of favourable composition . Si_3N_4 or MnS) and division.

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13743 SOME RECENT DEVELOPMENTS IN MAGNETISM IN CZECHOSLOVAKIA. L.Valenta.

Phys. Radium, Vol. 20, No. 2-3, 414-20 (Feb.-March, 1959).

A brief summary of: (1) magnetic relaxation in $MnFe_2O_4$; dependence of the line breadth of the resonance line on the ontaneous magnetization in polycrystalline manganese and manga-se zinc ferrites and the question of the experimental verification the theory of Clogston et al; (3) a new possibility of explaining deviations from the initial permeability law for the case of ation of the vector of the spontaneous magnetization; (4) concer-g the spontaneous magnetization near saturation; (5) a new method measuring the magnetocaloric effect in ferrites; (6) about the nsequent introduction of the Néel idea of the magnetic sublattices Heisenberg's theory and its generalization for ferrimagnetics, iferromagnetics and thin films with an arbitrary spin; (7) influ-ce of the inhomogenity of the demagnetizing field on the ferromagnetic resonance; (8) the theory of the domain structure in thin films of MnBi; (9) the explanation of the hysteresis of the ballistic demagnetizing factor; (10) concerning the definition of the parameter p characterizing the non-ellipsoidal specimens; and (11) demagnetization of ferromagnetic materials by an alternating magnetic field.

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13744 THE THEORY OF SPIN WAVES.

M.A.Gintsburg.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 336-8 (Oct., 1959).

Discusses various aspects of a unified theory of spin waves and electromagnetic waves (Abstr. 3117 of 1960). Criticizes some previous work (Abstr. 2996 of 1956; 8863 of 1958). D.J.Oliver

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13745 COMMENTS ON THE ABOVE LETTER BY DR.M.A.GINTSBURG.

A.M.Clogston, H.Suhl and L.R.Walker.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 338-9 (Oct., 1959).

The authors do not regard Gintsburg's criticism as affecting their previous work. D.J.Oliver

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13746 THEORY OF SPIN WAVES.

M.A.Gintsburg.

Fiz. tverdogo Tela, Vol. 2, No. 5, 913-21 (May, 1960). In Russian.

Preliminary results are given for the dispersion law for spin waves in (a) loss-less ferromagnetics and (b) real ferromagnetics. R.B.Stinchcombe

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13747 QUANTIZATION OF SPIN WAVE FIELD.

I.Mannari.

Progr. theor. Phys., Vol. 19, No. 4, 451-2 (April, 1958).

Presents a slight modification of previous work by Frank (Abstr. 6707 of 1957). D.M.Edwards

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13748 BOSE—EINSTEIN LATTICE GASES EQUIVALENT TO THE HEISENBERG MODEL OF FERRO-, ANTIFERRO- AND FERRI-MAGNETISM.

T.Morita.

Progr. theor. Phys., Vol. 20, No. 5, 614-24 (Nov., 1958).

The Hamiltonians are presented which are equivalent to the Heisenberg model of ferro-, antiferro- and ferrimagnetism and which have the form of finite power series of the Bose operators. A techniques for calculations of partition function for a system with such a Hamiltonian that contains a term of infinite potential is presented and discussed in connection with the theories of a ferromagnetic spin system by Van Kranendonk and Dyson.

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13749 BOSE—EINSTEIN LATTICE GAS THEORY OF FERROMAGNETISM.

T.Morita.

Progr. theor. Phys., Vol. 20, No. 5, 728-36 (Nov., 1958).

Several calculations of the temperature dependence of the spontaneous magnetization of ferromagnet which have been published are not in agreement with one another. In this paper, it is calculated by applying the cluster development of a gas to the spin-deviation gas—the Bose—Einstein lattice gas equivalent to the Heisenberg model of ferromagnetism. The same results as Dyson has given (Abstr. 5998-9 of 1956) are obtained without meeting with the problems of non-diagonality, kinematical interaction or non-hermetic Hamiltonian.

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13750 ON THE EXCHANGE INTERACTION BETWEEN THE OUTER AND INNER ELECTRONS IN THE TRANSITION METALS.

S.V.Vonsovskii, A.A.Berdŷshev, Yu.A.Izyumov, B.V.Karpenko and Yu.Ya.Polyak.

Dokl. Akad. Nauk SSSR, Vol. 132, No. 4, 797-800 (June 1, 1960). In Russian.

An analytical study of the problem is presented, its conclusion being that an effective (indirect) coupling between the inner electrons is produced as a result of the exchange interaction between the inner and outer electrons of the transition metals. In the absence of direct d—d exchange, the interaction under consideration can, owing to its ferromagnetic nature, lead only to ferromagnetism. The energy spectrum of the spin waves is not qualitatively changed as a result of the indirect interaction through the conduction electrons which can result only in re-normalization of the exchange integral. M.H.Sloboda

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13751 MAGNETIC GRADIENT AT THE SURFACE OF FERROMAGNETIC SUBSTANCES. S.Yamaguchi.

J. Electrochem. Soc., Vol. 107, No. 4, 357-9 (April, 1960).

The determination is made by studying the diffraction of an electron beam. It is concluded that the maximum magnetic gradient is related to the lattice distortion or the magnetostriction found at the surface of the specimen and that this fact makes the technique useful in studying corrosion problems. D.J.Oliver

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13752 MAGNETIC FIELD IN A CAVITY. W.H.Meiklejohn.

J. Phys. Radium, Vol. 20, No. 2-3, 88-92 (Feb., 1959).

The classical Lorentz field in a spherical cavity of $4\pi M_S/3$ does not occur in a ferromagnetic material which has reached technical saturation. This effect is due to the formation of closure domains in the material near the surface of the cavity. Measurements of a material of low saturation magnetization shows that the field in the cavity approaches $4\pi M_S/3$ only at fields that are five times the maximum demagnetizing field in the material. These results show that cavities or non-magnetic inclusions will greatly effect the approach to saturation in ferromagnetic materials, as point out by Néel.

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13753 SOME FURTHER RESULTS ON FERROMAGNETISM IN RELATION TO SUPERCONDUCTIVITY.

H.Suhl, B.T.Matthias and E.Corenzwit.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 346-8 (Oct., 1959).

Compounds of the form AB_2 become ferromagnetic at low temperatures if A = Nd, and superconducting if A = Y; in both cases the transition temperature is highest when the nominal valency of B (=Re, Os, Ir, Pt) is about 7. The coexistence of ferromagnetism and superconductivity, previously reported in $(Ce,Gd)Ru_2$ compounds (Abstr. 3512 of 1959), is shown much more clearly in $(Y,Gd)Os_2$ compounds. R.G.Chambers

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13754 ELECTRON INTERACTIONS AND FERROMAGNETISM IN METALS. D.M Edwards and E.P.Wohlfarth.

J. Phys. Radium, Vol. 20, No. 2-3, 136-7 (Feb.-March, 1959).

It is suggested that the effects of electron correlation in metallic ferromagnetics, which must be included in discussions based on the collective electron treatment, could considered from the point of view of plasma theory, and that some features of the spin wave treatment are thereby introduced.

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13755 THE MAGNETIC AFTER-EFFECT. P.Brissonneau.

J. Phys. Radium, Vol. 19, No. 4, 490-504 (April, 1958). In French.

The magnetic after-effect is defined, its limits indicated and published work reviewed. The results are interpreted by two mechanisms only, firstly the after-effect due to thermal fluctuation of the direction of the spontaneous magnetization, and secondly the diffusion after-effect of localized faults in the ferromagnetic lattice. In most cases it should be possible to distinguish these mechanisms unambiguously by their different characteristics.

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13756 THE DETERMINATION OF THE HYPERFINE COUPLING IN FERROMAGNETIC METALS BY NUCLEAR ORIENTATION AND LOW TEMPERATURE SPECIFIC HEATS. N.Kurti.

J. Phys. Radium, Vol. 20, No. 2-3, 141-4 (Feb.-March, 1959).

The hyperfine coupling in metallic cobalt and in cobalt alloys has been determined both by nuclear orientation and by low temperature specific heats. The results are discussed in the light of Marshall's theoretical predictions (Abstr. 5107 of 1958). Specific heat measurements in terbium metal indicate a hyperfine coupling which is about 6% smaller than that found for the Tb^{+++} ion in a paramagnetic salt.

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13757 RESULTS OF STUDIES ON CERTAIN MAGNETIC AND MAGNETO-OPTICAL PROPERTIES OF FERROMAGNETIC MATERIALS. V.I.Cecernikov, U.Hoffmann, E.I.Kondorskij, G.S.Krincik, N.Z.Mirjasov, A.P.Parsanov, V.E.Rode and D.I.Volkov.

J. Phys. Radium, Vol. 20, No. 2-3, 195-7 (Feb.-March, 1959). In French.

Low temperature measurements of the saturation magnetization of Ni–Cu alloys are given and agree with the $T^{3/2}$ law. The exchange integral is calculated. The magnetic properties of the system Mn–B are investigated. The compound MnB is the ferromagnetic component in these alloys. The results of measurements of the paramagnetic susceptibility of ferromagnetic materials at high temperature, (up to 1600° C), are given. Resonance effects in ferromagnetic substances in the infrared region have been observed Some mechanisms are proposed.

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13758 ON THE INFLUENCE OF $3d^4$ IONS ON THE MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF MAGNET OXIDES. J.B.Goodenough.

J. Phys. Radium, Vol. 20, No. 2-3, 155-9 (Feb.-March, 1959).

After a brief reference to the physical basis for a tetragonal distortion ($c/a > 1$) of an octahedral anion interstice which is occupied by a cation with outer-electron configuration $3d^4$, the crystallographic properties of several Mn^{3+}-containing oxides are given to illustrate the significance of this effect for determining the crystalline symmetry. A structure for the orthorhombic $LiMnO_2$ phase is proposed which is consistent with the powder-pattern data reported in the literature. It is also pointed out that $3d^4$ cations may simultaneously couple ferromagnetically and antiferromagnetically with similar cations if the local octahedron is distorted to tetragonal symmetry. This effect is illustrated in both the perovskite-type and the spinel-type lattice. Also three different types of $Mn^{3+}-Mn^{3+}$ interaction are illustrated. It is pointed out that the magnetic properties of several Mn^{3+}-containing, perovskite-type oxides can be interpreted as due to this peculiar property of the Mn^{3+} ion.

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13759 SOME RECENT ADVANCES IN THE STUDY OF MAGNETIC COMPOUNDS. T.Nagamiya.

J. Phys. Radium, Vol. 20, No. 2-3, 70-81 (Feb.-March, 1959).

Recent Japanese experimental and theoretical studies on magnetic compounds are reviewed. They include measurements on artificial single crystals of NiO, FeS, Fe_7S_8, natural single crystals of ilmenite–hematite solutions, artificial polycrystals of ilmenite–hematite solutions and ferrite–chromite solutions, theories on FeO, CoO, $FeCl_2$, $CoCl_2$, $NiCl_2$, $MnBr_2$, spin superstructure of the rutile type crystal, CoF_2, etc., and some superexchange considerations.

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13760 FERROMAGNETIC PHASE TRANSITIONS AND THE SYMMETRY OF CRYSTALS. L.A.Shuvalov.

Kristallografiya, Vol. 4, No. 3, 399-409 (May-June, 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 3, 371-80 (March, 1960).

The change in point crystallographic and magnetic symmetry in all classes of crystals with possible ferromagnetic phase-transitions is discussed and tabulated.

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13761 [THEORETICAL STUDY OF] FERROMAGNETISM IN AN IMPERFECT CRYSTAL USING THE ISING APPROXIMATION. J.Seiden.

J. Phys. Radium, Vol. 20, No. 11, 876-89 (Nov., 1959). In French.

The influence of lattice defects on thermodynamic properties of ferromagnetic materials was studied. The theory of the Ising model for an imperfect square lattice is expounded. The partition function of the imperfect square lattice is calculated rigorously to the first order in c (c is the concentration of lattice defects). It is proved that the theory can also be applied to the imperfect cubic lattice. It is shown that when $c < 0.1$, the phase transition of the imperfect crystal is of the same type as the transition of the perfect crystal for a large class of lattice defects, and a simple formula for the Curie temperature of the imperfect lattice is obtained. The theory is compared with experiments on the Curie temperature of alloys of nickel with a nonferromagnetic metal. The theory gives the correct order of magnitude, but the Ising model, because it neglects the band structure of electronic spectra in metals, cannot provide a wholly satisfactory quantitative treatment of ferromagnetic alloys in the vicinity of their Curie temperature.

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13762 MAGNETIC STATES OF A UNIAXIAL CRYSTAL WITH POSITIVE MOLECULAR FIELD COEFFICIENTS.

A.J.P.Meyer.

C.R. Acad. Sci. (Paris), Vol. 250, No. 22, 3611-12 (May 30, 1960). In French.

Discusses the equilibrium of the magnetization for a uniaxial crystal containing two ferromagnetic sublattices. E.P.Wohlfarth

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13763 PREDICTION OF THE PARAMAGNETIC SUSCEPTIBILITY OF FERROMAGNETIC MATERIALS. APPLICA- ON TO COBALT.

D.Taupin and G. Fournet.
Phys. Radium, Vol 20, No. 6, 477-81 (April, 1959). In French

By means of the Yvon cooperative phenomena theory, the para- agnetic susceptibility of ferromagnetic materials has been obtained. considering the Ising model, the influence of the terms of 2 sites, sites, 4 sites, etc. may be studied. The interaction energy tween first, second, third, etc., nearest neighbours can also be troduced. The theoretical curve χ(T) for cobalt is in quite good reement with observation.

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13764 RELATIONSHIP BETWEEN THE GRAIN DIMENSIONS AND THE MAGNETIC PROPERTIES OF AMALGAMS F IRON AND OF COBALT.

W.Henning and E.Vogt.
Phys. Radium, Vol. 20, No. 2-3, 277-81 (Feb.-March, 1959). French.

Applying Langevin's theory to the superparamagnetic state one nds that the initial slope of the $I = f(T/H)$ curves depends only on e total number of particles, and neither on distribution of their lumes nor on the temperature. Measurements made on a freshly epared Fe-amalgam show a decrease of saturation magnetization about 20% between 81° and 293° K, which seems to be caused by e Klein–Smith effect. From the temperature dependence of rem- ence the distribution function of particle size for a Co-amalgam different states of aging is deduced by the method of Weil and runer. The mean value ν of the particle volume can be calculated om the initial slope of $I = f(T/H)$ curves, and the square mean lue ν^2 from the initial susceptibility. The consequences of particle ze on the distribution function are discussed and compared with e results of the remanence method.

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13765 SOME MAGNETIC PROPERTIES OF DILUTE FERROMAGNETIC ALLOYS.

W.Sucksmith.
Phys. Radium, Vol. 20, No. 2-3, 290-4 (Feb., 1959).

A continuation of previous experiments (see Abstr. 6297 of 55). The work has been extended to the production of precipi- tes, in which departure from spherical shape is produced by cold awing of suitable alloys. Magnetic measurements on the anisotropic ecimens so produced are shown to give evidence for the distri- tion of particle shape, size and structure. The reverse magnetic eld required to reduce the remanence to zero is shown to be an ditional useful parameter in these determinations. Microphoto- aphs of the samples showed that in all three cases the precipi- tes of the specimens of maximum coercivity were larger than ould have been expected from single domain particles.

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13766 SOME MAGNETIC PROPERTIES OF PLATINUM-RICH Pt–Fe ALLOYS.

J.Crangle.
Phys. Radium, Vol. 20, No. 2-3, 435-7 (Feb.-March, 1959).

Measurements of magnetic susceptibility and spontaneous agnetization on face centred cubic platinum-iron alloys having ompositions around Pt_3Fe and also on alloys with lower iron ontents, are reported. In the Pt_3Fe superlattice region the alloys opear to be antiferromagnetic when ordered and ferromagnetic hen disordered. The more dilute alloys are ferromagnetic, even own to 2 at. % of iron.

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13767 ORIENTATION SUPERSTRUCTURES OF Fe–Co ALLOYS.

E.T.Ferguson.
Phys. Radium, Vol. 20, No. 2-3, 251-3 (Feb.-March, 1959). French.

Measurements of the magnetic anisotropy of a 50% Fe–Co alloy ter various heat treatments in a magnetic field show that the opearance of a normal superstructure reduces the induced uniaxial agnetic anisotropy, in agreement with theory.

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13768 ORIENTATION SUPERSTRUCTURES CREATED BY MECHANICAL DEFORMATION OF AN Fe–Ni ALLOY.

.Vergne.
Phys. Radium, Vol. 20, No. 2-3, 254-7 (Feb.-March, 1959). In rench.

It is shown that directional ordering is produced in Fe–Ni alloys ter a heat treatment while applying a mechanical stress. Measure- ents of the energy needed to attain magnetic saturation as a func- on of the stress are discussed and the results are satisfactorily terpreted by mean of Néel's theory.

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13769 ORIENTATION SUPERLATTICE FORMED BY NEUTRON IRRADIATION IN A MAGNETIC FIELD OF A (50–50%) Fe–Ni ALLOY.

J.Paulevé and D.Dautreppe.
C. R. Acad. Sci. (Paris), Vol. 250, No. 23, 3804-6 (June 8, 1960). In French.

A specimen of the Fe–Ni alloy was bombarded by fast neutrons in a magnetic field of 2500 Oe. A marked uniaxial magnetic anisotropy developed. The evolution of a superlattice by annealing in a magnetic field was studied. J.Thewlis

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13770 ON THE ANISOTROPY CONSTANTS OF FERROMAGNETIC CUBIC CRYSTALS.

A.S.Viglin.
Fiz. tverdogo Tela, Vol. 2, No. 2, 331-46 (Feb., 1960). In Russian.

A long, mathematical paper, of which the first section is a general discussion of the value of the anisotropy energy, U, of a cubic crystal, expressed as the sum of a set of products of the magnetization components, 2, 4, 6, 8, etc., at a time, each product being multiplied by a constant coefficient. From symmetry considerations, the original expression for U is simplified. In the second section the number R_0 of invariants of degree n is calculated. Table 1 shows their algebraic values up to n = 8. In the third section is calculated T_n, the number of linearly independent relations between the invariants of degree not exceeding n. Table 2 gives numerical values of T_n, and also of S_n, the number of invariants, from n = 1 to n = 29. The fourth section considers sets of anisotropy constants. In three mathematical appendices further details of certain calculations are given. N.Davy

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13771 MAGNETIC ANISOTROPY AND CRYSTAL STRUCTURE OF A SINGLE CRYSTAL OF MAGNETITE AT TEMPERATURES BELOW THE PHASE TRANSITION.

N.P.Narovskaya.
Kristallografiya, Vol. 3, No. 3, 346-50 (1958). In Russian.
English translation in: Soviet Physics–Crystallography (New York), Vol. 3, No. 3, 348-51 (May-June, 1958).

Reports results of measurements of torque curves on a single crystal cooled in a magnetic field. If the curves are measured at –195°C after application of a strong field (9×10^3 oersted) revolving in a plane normal to the orthorhombic axis, a uniaxial anisotropy in this plane and a mosaic structure are developed due to a local rotation of this axis. E.P.Wohlfarth

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13772 DETERMINATION OF THE MAGNETIC ANISOTROPY ENERGY, CAUSED BY INTERSTITIAL CARBON OR NITROGEN IN IRON.

G.de Vries, D.W.van Geest, R.Gersdorf and G.W.Rathenau.
Physica, Vol. 25, No. 11, 1131-8 (Nov., 1959).

The magnetic anisotropy caused by interstitial atoms in iron is, not considering changes in lattice constants, described by

$$D\{(\alpha_1^2 - \tfrac{1}{3})\,C_x + (\alpha_2^2 - \tfrac{1}{3})\,C_y + (\alpha_3^2 - \tfrac{1}{3})\,C_z\};$$

C_x, C_y and C_z are deviations from the mean concentrations of interstitials at the different types of sites. The constant D is determined in two experiments; a direct measurement of induced magnetic anisotropy and the measurement of the after effect of the magnetostriction. The results, that are in good agreement, yield: 7.2×10^6 joule/m³ for carbon and 4.7×10^6 joule/m³ for nitrogen.

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13773 THE INFLUENCE OF INTERSTITIALLY DISSOLVED CARBON AND NITROGEN ON THE MAGNETIC ANISOTROPY OF IRON AND ON THE MOBILITY OF BLOCH WALLS.

G.de Vries.
Physica, Vol. 25, No. 11, 1211-21 (Nov., 1959).

The influence of interstitial atoms on the magnetic properties of iron was investigated. Two causes for this influence are considered: the magnetostriction and a direct interaction of the interstitial atoms with the magnetization vector. Equations are given for the effect upon the magnetostriction and the magnetic anisotropy. The stabilization of a 90° wall lying in a (110) plane was investigated in detail. It is shown that the stabilizing force on a 90° wall may reach a maximum value that is considerably higher than the value computed for large displacements. The integrals needed in these computations are given. These integrals can also be used for calculation on other types of Bloch walls.

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13774 THE ANISOTROPY OF MAGNETIZATION OF THE UNORDERED ALLOY Ni$_3$Mn AT HELIUM TEMPERATURES. N.V.Volkenshtein and M.I.Turchinskaya.
Zh. eksper. teor. Fiz., Vol. 38, No. 1, 270-1 (Jan., 1960). In Russian.

Measurements were made of magnetization of a monocrystal of Ni$_3$Mn alloy in three crystallographic directions at room temperature and at temperatures of liquid nitrogen, hydrogen and helium At room temperature the induction varies linearly with magnetic field and anisotropy is absent. At the temperature of liquid nitrogen and lower, the curves $4\pi I(H)$ have the shape typical for ferromagnetics and anisotropy is present. The saturating field increases with decreasing temperature and this is probably due to a transition of Ni$_3$Mn from the ferromagnetic to the antiferromagnetic state.
Z.Krasucki

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13775 VARIATION OF SATURATION MAGNETIZATION AND THE ELECTRICAL RESISTANCE OF Fe–Ni ALLOYS UNDER THE EFFECT OF AN ISOTROPIC COMPRESSION AT LOW TEMPERATURES. E.I.Kondorskij and V.L.Sedov.
J. Phys. Radium, Vol. 20, No. 2-3, 185-91 (Feb.-March, 1959). In French.

The saturation magnetization and electrical resistance of binary Fe–Ni alloys, with 38 and 45% Ni, were studied as a function of pressure. The pressure was created by freezing water in a beryllium bronze bomb. Measurements were made from 1.7 to 77° K, in fields up to 7000 Oe. The limiting values of the saturation magnetization and the electrical resistance as $T \to 0$ were shown to depend on the isotropic compression, the variations having opposite signs. In large applied fields, the limiting values also vary with the field, and the differential susceptibility at saturation does not become zero as $T \to 0$. The ratio between the relative variation of the saturation magnetization and the relative variation of the resistivity is nearly the same for both external parameters, pressure and field.

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13776 MAGNETIZATION IN A STRONG FIELD AND THE APPROACH TO ABSOLUTE SATURATION OF NEODYMIUM AND DYSPROSIUM. W.E.Henry.
J. Phys. Radium, Vol. 20, No. 2-3, 192-4 (Feb.-March, 1959). In French.

Magnetic moments have been measured directly, by a sample motion ballistic method on neodymium and dysprosium. For neodymium, difficult to saturate, the measurements were made in magnetic fields up to 70 000 G and at temperatures in the liquid helium region. At 1.3° K and 70 000 G the measured moment is 1.5 Bohr magnetons per atom of neodymium and the extrapolation yields not more than 1.65 Bohr magnetons per atom as compared with 3.3 Bohr magnetons per atom calculated from quantum numbers. The small remanence increases between 4.2 and 1.3° K. The absolute moment measured for dysprosium at 1.3° K and 78 000 G is 7.6 Bohr magnetons per atom. The remanent moment increases from 0.04 Bohr magneton per atom at 140° K to 0.67 Bohr magneton per atom at 1.3° K.

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13777 INFLUENCE OF NEUTRON IRRADIATION OF THE MAGNETIZATION CURVES OF IRON SILICIDE SINGLE CRYSTALS. V.V.Klyushin.
Dokl Akad. Nauk SSSR, Vol. 132, No. 1, 102-3 (May 1, 1960). In Russian.

B–H curves of iron silicide (3% Si) in the [001] and [111] directions are compared before and after irradiation with 4.7×10^{18} neutrons/cm^2. The small changes are attributed to alteration in the domain boundaries.
R.F.S.Hearmon

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13778 THE NUMERICAL SOLUTION OF THE MAGNETIC-FIELD EQUATION IN SATURATED IRON. A.S.Kronrod.
Dokl. Akad. Nauk SSSR, Vol. 132, No. 1, 95-7 (May 1, 1960). In Russian.

The author suggests a faster iteration procedure for cases when the hysteresis curve has a high slope. The Laplace equation for the magnetic potential is then found to behave analogously to the diffusion equation.
J.K.Skwirzynski

539.2 : 538.2

13779 ANOMALIES IN THE MAGNETIC PROPERTIES OF THE IRON–ALUMINIUM ALLOYS AT ELEVATED TEMPERATURES. Sh.I.Zusman.
Metallov i Metallovedenie, Vol. 9, No. 1, 41-7 (1960). In Russian.

Hysteresis loops were obtained (for specimens containing 8.5, 9.5, 10.6, 12.8 and 15.3 wt % Al) at various temperatures ≤ 550° C. The measurements were taken during both heating and cooling, the experiments in the latter case being conducted both with and withou the application of a magnetic field. At high temperature, alloys with 8-13% Al had properties similar to those of alloys of Perminvar type; traces of the "Perminvar effect" persisted at room temperature in the form of increased sensitivity to strong magnetic fields and anomalously low magnitude of the remanent induction. There was a definite relationship between the "Perminvar effect" and the effect of the thermomagnetic treatment (in that they became apparent in the same temperature range and that their intensity increased with rising temperature), from which the identity of the physical nature of the two effects was inferred. The fact that neithe of these effects had been observed in the 12.8% Al alloy, cooled to room temperature, was attributed to its fully ordered structure, and it was postulated that in the case of alloys, undergoing a disorder–order transformation, these effects become apparent only in the intermediate stages of ordering or when the alloy is in the disordered condition.
M.H.Sloboda

539.2 : 538.2

13780 SOME CONSEQUENCES OF THE ANALYTICAL THEOR OF THE FERROMAGNETIC HYSTERESIS.
G.Biorci and D.Pescetti.
J. Phys. Radium, Vol. 20, No. 2-3, 233-6 (Feb.-March, 1959).

Some properties of the transformations in the (J, H) plane of a ferromagnetic material are described. They are consequences of the Preisach model which considers the material as composed of independent elements of volume whose magnetic behaviour is wholly described by a rectangular loop, and assumes that the distribution of elemental loops, statistically independent of J and H, is a property of the material. The most interesting property concerns the determination of the region of the plane (J, H) where the magnetization curve can be found, once the loop is known, and the region where the loop can be found, once the magnetization curve is given. The coercive force of a symmetrical loop cannot be larger than the field strength corresponding to $J_V/2$ on the magnetization curve, J_V being the intensity of magnetization at the vertex of the loop.

539.2 : 538.2

13781 HYSTERESIS LOSSES ALONG OPEN TRANSFORMATIONS. G.Biorci and A.Ferro.
J. Phys. Radium, Vol. 20, No. 2-3, 237-40 (Feb.-March, 1959).

It is shown that the analytical theory of hysteresis, which determines the value of J at the end of an arbitrary path of H if the magnetization curve and the saturation loop are known, can be extended to compute the energy losses due to hysteresis along an arbitrary transformation, open or closed, in the (J, H) plane. The theoretical data have been computed for a soft iron specimen and for an Alnico type material. The latter have been compared with experimental data taken by Bates and Simpson on a similar material The quantitative agreement between theoretical and experimental curves is quite satisfactory.

539.2 : 538.2

13782 DOUBLE HYSTERESIS LOOPS IN FERROMAGNETIC CRYSTALS. A.A.Hirsch.
J. Phys. Radium, Vol. 20, No. 2-3, 262-3 (Feb.-March, 1959). In French.

A single domain with mixed magnetocrystalline and uniaxial anisotropies can show a magnetization curve composed of two asymmetric loops connected by a section over which the magnetization is reversible. The ireversible process starts at a critical field. The double loop could be a possible explanation for the mechanism of magnetization in materials with contricted loops such as Perminvars

539.2 : 538.2

13783 THE COERCIVE FORCE AND ROTATIONAL HYSTERESIS OF ELONGATED FERROMAGNETIC PARTICLES. S.Shtrikman and D.Treves.
J. Phys. Radium, Vol. 20, No. 2-3, 286-9 (Feb.-March, 1959).

The coercive force of an infinite ferromagnetic cylinder is calculated as a function of the radius and of the inclination of the axis to the applied field. For this calculation it is assumed that only curling and rotation in unison take place; and that whenever the curling is associated with a discontinuous jump, the magnetization is brought to the lower energy state given by Stoner and Wohlfarth (Abstr. 1877 of 1948). Using the same assumptions, the rotational hysteresis loss and integral are calculated both for an aligned and for a random assembly of cylinders. The results are found to be in fair agreement with the measurements of Jacobs and Luborsky on elongated ferromagnetic particles (Abstr. 1779 of 1958).

539.2 : 538.2

13784 MAGNETIC HYSTERESIS AND DOMAIN STRUCTURE.

R.S.Tebble.

Phys. Radium, Vol. 20, No. 2-3, 98-100 (Feb.-March, 1959).

A brief survey is made of some of the problems involved in the velopment of experimental methods of obtaining information on the main processes involved in the low field magnetization of polyystalline materials.

539.2 : 538.2

13785 ON THE THEORY OF PERMEABILITY DISACCOMMODATION IN AN ALTERNATING FIELD.

S.Krupička.

ech. J. Phys., Vol. 10, No. 1, 40-4 (1960).

Neel's theory of diffusion magnetic after-effect is used to show at the disaccommodation of the initial permeability in an alternat; field of sufficiently high frequency is equal to the disaccommodan determined by the ballistic method.

539.2 : 538.2

13786 NEW MEASUREMENTS ON TIME DECREASE OF PERMEABILITY.

.J.Bosman, P.E.Brommer and G.W.Rathenau.

Phys. Radium, Vol. 20, No. 2-3, 241-3 (Feb.-March, 1959).

The disaccommodation of Fe—Si alloys has been measured. the region where the magnetostriction constant h_1 changes sign e disaccommodation is little affected. It seems that the disacommodation due to carbon is larger than the effect due to a coresponding atomic percentage of nitrogen, although the contrary is ue for internal friction. The ratio of the diffusion coefficients of ^{12} and C^{13} in pure iron has been determined, again by measuring e disaccommodation. A value of (1.04 ± 0.01) in agreement with $(m)^{-1/2}$ relationship for the diffusion coefficient has been measured.

539.2 : 538.2

13787 THE ANALYSIS OF THERMOMAGNETIC MEASUREMENTS IN WEAK FIELDS.

L.F.Bates and H.Clow.

Phys. Radium, Vol. 20, No. 2-3, 93-7 (Feb.-March, 1959).

The thermal changes which accompany magnetization in weak elds were measured for a series of nickel—cobalt alloys of different ercivities to provide information concerning the magnetic processes ich produce an interesting phenomenon, known as the "dip" between H_c and $+H_c$. Analysis of the experimental results gives support r the Néel disperse field theory of domain wall motion.

539 2 : 538.2

13788 MICROMAGNETICS: SUCCESSOR TO DOMAIN THEORY?

W.F.Brown, Jr.

Phys. Radium, Vol. 20, No. 2-3, 101-4 (Feb.-March, 1959).

In domain theory, the domain and wall concepts are treated as ndamental as soon as the thickness and energy of a wall have been lculated. The alternative considered here is a complete, selfonsistent, three-dimensional calculation based on the continuousagnetization concept, in which domains and walls are not postulated; hen they are valid concepts, they must emerge automatically from e theory. The stable equilibrium states are solutions of a nonlinear oundary-value problem. This problem has been solved in the onemensional case of traditional domain theory, in linearizable cases nearly uniform magnetization, and in special nonlinear cases nenable to a Ritz approximation or to numerical solution by higheed computers.

539.2 : 538.2

13789 CORRECTION TO A SINGLE DOMAIN CALCULATION.

P.Gaunt.

roc. Phys. Soc., Vol. 75, Pt 4, 625-6 (April 1, 1960).

Corrects the calculation of Stacey (Abstr. 11207 of 1959); the laxation time is 5×10^{30} sec rather than 5×10^{-8} sec.

E.P.Wohlfarth

539.2 : 538.2

13790 ON THE INFLUENCE OF THE DEMAGNETIZING FIELD ON DOMAIN STRUCTURE.

J.Kociński.

cta phys. Polon., Vol. 17, No. 5, 283-94 (1958).

It has been found that the demagnetizing field acting near the d of a crystal rod, with mean magnetization parallel to the long is of the rod, exerts a great influence on the domain structure of e crystal. The result of the approximate calculation shows that is effect explains partly the discrepancy found between experiment d Neel's theory of the domain structure of such a crystal. It may that the discrepancy that remains depends on the approximations ade in the calculation. The formula obtained for the double domain idth d goes over into Néel's formula for a needle-shaped crystal.

539.2 : 538.2

13791 THE EFFECTS OF INTERACTIONS BETWEEN ELEMENTARY FERROMAGNETIC DOMAINS: TILTING AND CREEPING.

L.Néel.

J. Phys. Radium, Vol. 20, No. 2-3, 215-21 (Feb.-March, 1959).
In French.

An elementary theory of coupled ferromagnetic square-loop domains, based on a detailed investigation of the properties of two coupled domains. Some new phenomena are theoretically predicted, in particular "tilting". This is a positive or negative change of the magnetization in a field H_A, induced by varying the field a number of times between H_A and H_B. If the coupling of the part of the sample whose magnetization changes during the loop between H_A and H_B and the rest of the sample is represented by a statistically fluctuating field, another new phenomenon, "reptation" (creep), occurs: the hysteresis loop between H_A and H_B undergoes a gradual displacement, depending on the number of alternations of the field. These predicted effects have been experimentally observed.

539.2 : 538.2

13792 EXPERIMENTAL RESULTS ON CREEPING AND TILTING IN HYSTERESIS LOOPS.

Nguyen-Van-Dang.

J. Phys. Radium, Vol. 20, No. 2-3, 222-8 (Feb.-March, 1959).
In French.

The experimental effects of the reptation (creeping) of asymmetrical hysteresis loops are reviewed, and it is shown that, for all initial magnetic states, the reptation after n cycles follows the $(\log n)^{1/2}$ law. For all temperatures between 20 and 290° K, the reptation is small when h, the amplitude of the loop, is smaller than half the coercive field H_c, has a maximum when $h \simeq H_c$ and becomes small for $h > 2$ or $3\ H_c$. The results agree with Néel's theory. The anomalous behaviour when n is small can be interpreted as "tilting", and appears to confirm Néel's theoretical analysis of this second phenomenon.

539.2 : 538.2

13793 CONFIGURATION OF THE DOMAINS IN FERROMAGNETIC CRYSTALS.

L.V.Kirenskii and M.K.Savchenko.

Kristallografiya, Vol. 4, No. 5, 702-9 (Sept.-Oct., 1959). In Russian.
English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 663-9 (May, 1960).

By simultaneous examination of powder patterns by means of two microscopes on opposite sides of ferromagnetic crystals, it was possible to follow the variation of the boundaries between the domains within the crystals, and draw conclusions as to the shape of the domains. Rotation of the interdomain boundaries under the action of stresses and the character of the displacement of the boundaries for different domain structures under the action of a magnetic field have been established experimentally.

539.2 : 538.2

13794 MICROSCOPIC OBSERVATION OF THE STRAIGHT AND CURVED MAGNETIZATION STRUCTURES BY MEANS OF THE FARADAY EFFECT.

H.Boersch and M.Lambeck.

Z. Phys., Vol. 159, No. 3, 248-52 (1960). In German.

Ferromagnetic domains in thin evaporated films of iron were made visible by means of Fowler and Fryer's method (Abstr. 2418 of 1957) and by the use of a microscopic high-resolution technique. Domains with straight and curved directions of magnetization were observed. Curved domains can also be interpreted as Néel walls with small curvature.

539.2 : 538.2

13795 DOMAIN CONFIGURATIONS IN CUBIC CRYSTALS OF POSITIVE ANISOTROPY WITH SUPERIMPOSED UNIAXIAL ANISOTROPY.

J.O.Artman and S.Foner.

J. Phys. Radium, Vol. 20, No. 2-3, 105-8 (Feb.-March, 1959).

An analysis of domain configurations for a cubic crystal of positive anisotropy with superimposed uniaxial anisotropy is given. Various multi- and single-domain configurations are predicted as a function of magnitude and direction of applied field in terms of the magnetic parameters. Critera for transitions between these configurations are given. The analysis is applied to magnetic data for magneto-thermally annealed single-crystal cobalt ferrite. Agreement with the proposed models is obtained.

539.2 : 538.2

13796 DOMAIN PATTERNS AND REVERSALS BY WALL MOVEMENTS OF THIN FILMS OF IRON AND NICKEL IRON.

C.E.Fuller.

J. Phys. Radium, Vol. 20, No. 2-3, 310-18 (Feb.-March, 1959).

The reversal of the direction of magnetization by domain wall movements has been studied on two thin evaporated ferromagnetic films (Fe and Ni—Fe) by the Bitter colloid technique. For each film the magnetization reversal was observed both parallel and perpendicular to the direction in which a magnetic field was applied during evaporation. The behaviour of the iron film is similar in both directions but in the case of the nickel—iron film the reversal of magnetization in the perpendicular direction takes place mainly by rotation.

539.2 : 538.2

13797 MAGNETIC STRUCTURE OF FERROMAGNETIC SOLIDS. Ja.S.Šur.

J. Phys. Radium, Vol. 20, No. 2-3, 113-19 (Feb.-March, 1959). In French.

The magnetic structure of some ferromagnetics investigated by means of powder patterns are reported. It was shown on single crystals of silicon—iron that only certain closure domains could be nuclei of the reversed domains, but never the sub-domain (the closure domains situated near different inclusions). When the thickness of the laminar crystal of silicon—iron decreases its magnetic structure changes. The monodomain magnetic structure could be observed on the particles of the alloy MnBi with size from 5-30 μ. In studying the metastable magnetic states it was found that :
(a) at remanence, the magnetic structure may consist of basic domains, closure domains and basic domains with reversed magnetization; (b) magnetic hysteresis takes place as a consequence of the appearance and disappearance of closure domains; (c) after application and removal of an elastic stress, the magnetic structure is altered; (d) on changing the temperature a modification of the magnetic structure, which may be irreversible, takes place.

539.2 : 538.2

13798 DOMAIN STRUCTURE OF NICKEL AND IRON CRYSTALS. J.Kociński.

Acta phys. Polon., Vol. 18, No. 3, 169-89 (1959).

Different possible domain structures are considered. In each case the crystal has the shape of a rectangular rod with the long axis in the [100], [110] or [111] direction. The influence of an external magnetic field directed parallel to the long rod axis has been examined. The structures found consist of main domains and surface domains closing the magnetic flux. Domain structures of nickel crystals are found to be analgous to those of iron.

539.2 : 538.2

13799 A STUDY OF FERROMAGNETIC DOMAINS IN PERMINVAR POSSESSING A RECTANGULAR HYSTERESIS LOOP. E.W.Lee.

J.Phys. Radium, Vol. 20, No. 2-3, 109-12 (Feb.-March, 1959).

A brief account is given of a series of investigations directed towards understanding the properties of the elementary domains in "Perminvar" and 65-35 nickel—iron, which acquire rectangular hysteresis loops after being annealed in a magnetic field. Investigations using the magnetic Kerr effect show that in a "demagnetized" state, annular rings of these materials contain annular domains about 1 mm wide. Reversible permeability measurements indicate that the domain walls are very strongly held by internal forces. At high inductions magnetization takes place by radial movement of a single wall from the inner edge.

539.2 : 538.2

13800 BLOCH WALLS WITH DIV I ≠ 0. J.Kaczér.

J. Phys. Radium, Vol. 20, No. 2-3, 120-3 (Feb.-March, 1959).

Some types of Bloch walls, for which div I ≠ 0, are calculated. It is shown that such walls can occur under certain conditions even though they have higher energies associated with them. An explanation of so-called invisible walls is attempted.

539.2 : 538.2

13801 THE MAGNETIC REMANENCE DUE TO BLOCH WALL MOTION AND THE KINETICS OF DEMAGNETIZATION. B.Rothenstein.

Czech. J. Phys., Vol. 10. No. 2, 162-3 (1960). In French.

539.2 : 538.2

13802 FINE STRUCTURE OF BLOCH WALLS. S.Shtrikman and D.Treves.

J. appl. Phys., Vol. 31, No. 7, 1304 (July, 1960).

The observed periodic structure of 180° walls on iron whiskers, accompanied by zigzagging, is interpreted in terms of a reduction of the magnetostatic energy near the surface. E.P.Wohlfarth

539.2 : 538.

13803 RECENT MAGNETIC STRUCTURE STUDIES BY NEUTRON DIFFRACTION. C.G.Schull.

J. Phys. Radium, Vol. 20, No. 2-3, 169-74 (Feb.-March, 1959).

A review is presented of several magnetic structure studies performed recently by neutron diffraction methods. These include a study of the low temperature transition in Fe_3O_4 by Hamilton (Abstr. 8914 of 1958) and experiments by Roth (Abstr. 444, 2502 of 1959) on the magnetic structure ambiguities of the transition elemen monoxides. Recent studies using polarized neutron beam technique are described and data presented on the ferromagnetic scattering by iron and nickel.

539.2 : 538.

13804 A NEUTRON SCATTERING STUDY OF THE KINETICS OF MAGNETIC MOMENTS IN IRON IN THE REGION OF THE CURIE POINT. M.Ericson and B.Jacrot.

J. Phys. Radium, Vol. 20, No. 2-3, 178-9 (Feb.-March, 1959). In French.

The dynamics of the fluctuations of magnetization in iron near the Curie point have been worked out and the results support the validity of the Heisenberg model in iron.

539.2 : 538.

13805 NEUTRON SMALL-ANGLE SCATTERING BY SPIN WAVES IN IRON. R.D.Lowde and N.Umakantha.

Phys. Rev. Letters, Vol. 4, No. 9, 452-4 (May 1, 1960).

Describes experiments confirming the theoretical dependence o the scattered intensity on neutron wavelength and scattering angle, and on specimen temperature, setting and magnetization. As the temperature of the specimen is increased a nonlinear increase of intensity sets in at ~340°K and this is possibly due to the failure of the single spin-wave mechanism. D.J Oliver

539.2 : 538.

13806 CRITICAL SCATTERING OF NEUTRONS FROM CoO. A.W.Mc Reynolds and T.Riste.

J. Phys. Radium, Vol. 20, No. 2-3,175-7 (Feb.-March, 1959).

The angular distribution of neutrons scattered from CoO just above the Néel temperature is observed and analysed in the elastic approximation. It gives the correlation function for the direction of spins within each magnetic sublattice. The peaks observed are compared with those calculated from molecular field theory.

539.2 : 538.

13807 THE INTERPRETATION OF MAGNETIZATION MEASUREMENTS FOR PURE IRON AND NICKEL POLYCRYSTALS IN THE NEIGHBOURHOOD OF SATURATION. H.Danan.

J. Phys. Radium, Vol. 20, No. 2-3, 203-7 (Feb.-March, 1959). In French.

Magnetization measurements near saturation for pure polycrystalline iron and nickel may be interpreted by means of the paramagnetic susceptibility calculated by Holstein and Primakoff and the classical rotation term, without it being necessary to keep an a/H term in the law of approach to saturation. Polley's and Kneller's measurements and results on nickel are discussed and interpretated in the same way.

539.2 : 538.2

13808 REMANENT MAGNETIZATION OF FINE PARTICLES. E.P.Wohlfarth.

J. Phys. Radium, Vol. 20, No. 2-3, 295-7 (Feb.-March, 1959).

A brief review is given of some calculations of the remanent magnetization of fine particles. The remanence after previous saturation has been calculated for a number of different types of anisotropy. A discussion is also given of remanence curves attained after application of d. c. or a.c. fields, and relations between such curves are pointed out.

539.2 : 538.2

13809 THE ANISOTROPY OF VERY SMALL COBALT PARTICLES. C.P.Bean, J.D.Livingston and D.S.Rodbell

J. Phys. Radium, Vol. 20, No. 2-3, 298-302 (Feb.-March, 1959).

Torque and ferromagnetic resonance measurements on a single crystal of a copper—2% cobalt alloy have been made at various temperatures to determine the magnetocrystalline anisotropy of small single domain particles of precipitated cobalt. The anisotrop at 4.2°K is found to be independent of particle radius from 21 A to 77 A, lending support to a crystal field model of the origin of anisotropy. A slight variation of anisotropy with particle size was observed at higher temperatures, and was related to a slight variati in saturation magnetization with particle size at these temperatures

539.2 : 538.2

13810 MECHANICAL MODEL FOR UNIAXIAL MAGNETIC ANISOTROPY. H.J.Oguey.
v. sci. Instrum., Vol. 31, No. 7, 710-11 (July, 1960).

A mechanical model has been constructed as a means of derstanding certain properties of anisotropic thin films. The del renders possible direction finding of the magnetization for a ven amplitude and direction of the magnetic field vector lying in e plane of the film, provided rotational processes only are condered. The magnetic field is represented by the position of a mall knob, and can be set in its amplitude and direction. A inter then indicates the orientation of the magnetization vector. mp phenomena can be easily observed, the locii of which are the itical curve for the uniaxial anisotropy.

539.2 : 538.2

13811 A CONTRIBUTION TO THE STUDY OF THIN FILMS OF IRON AND OF NICKEL DEPOSITED ON COPPER BSTRATES AT VERY LOW TEMPERATURES. R.Conte and L.Weil.
Phys. Radium, Vol. 20, No. 2-3, 319-22 (Feb.-March, 1959). In ench.

Some magnetic properties of thin iron and nickel films deposited copper substrate at 4.2 and 20°K have been studied. Annealing room temperature produced important modifications of the ercive force and the remanent magnetization. This is interpreted a sign of structural rearrangement during annealing. In the case films deposited at 14°K, measurements at 20°K indicate that is rearrangement process has already occurred at the latter temperature.

539.2 : 538.2

13812 OBSERVATIONS OF THE MAGNETIZATION REVERSAL PROCESS IN THIN FILMS OF NICKEL—IRON, USING HE KERR MAGNETO-OPTIC EFFECT. M.Prutton.
rit. J. appl. Phys., Vol. 11, No. 8, 335-8 (Aug., 1960).

Observations of the magnetization reversal process in uniaxial in films of nickel—iron about 1500 A thick are reported. The perimental techniques used involve the comparison of measureents made in a Kerr magneto-optic apparatus, with the 400 c/s ysteresis loops taken with the pick-up loop both along and at right ngles to the applied field. The results suggest that the magnetizaon reversal process in a film orientated with its easy axis at an blique angle to the applied field occurs in three stages: (i) coherent otation until the angle is reached where a discontinuous jump in the ientation of the magnetization is expected to start; (ii) domain ucleation and growth from this angle to the angle where the jump hould finish; (iii) coherent rotation until the magnetization lays ong the field. The way in which some actual films differ from this odel is discussed.

539.2 : 538.2

13813 MAGNETIC PROPERTIES OF THIN NICKEL FILMS DEDUCED FROM STUDIES OF THE ELECTRICAL ONDUCTIVITY AND HALL EFFECT.
A.Colombani, G.Goureaux and P.Huet.
Phys. Radium, Vol. 20, No. 2-3, 303-9 (Feb.-March, 1959). In French.

Measurements of the electrical conductivity of thin nickel films were used to deduce the values of the ferromagnetic (T_f) and paramagnetic (T_p) Curie points for different thicknesses of film. The difference T_p-T_f, very large for thin films, slowly decreases when he number of atomic layers increases, and is only 26°C when the hickness reaches 1030 A. The values of the spontaneous magnetiation calculated by using the Cabrera formula, reach Weiss' values or bulk nickel at large film thickness, and show a sharp drop below 220 A at room temperature. Ferromagnetism is still apparent for a ilm 34 A thick. The curves differ quite clearly from the theoreical curves of Klein and Smith (Abstr. 4528 of 1951), even from hose as modified by Drigo (Abstr. 408 of 1952), referring to a constant magnetization. The Hall effect measurements give further nformation on the values and direction of the spontaneous magnetzation for different film thicknesses.

539.2 : 538.2

13814 ORIGIN OF THE MAGNETOMECHANICAL EFFECT IN AN ALTERNATING FIELD. K.Míšek.
Czech. J. Phys., Vol. 10, No. 2, 104-18 (1960).

Describes experiments on the internal friction of nickel in an alternating magnetic field. It was found that the effect is not caused by macroscopic eddy currents but by microscopic eddy currents connected with changes in domain structure, which microscopically have a reversible character and which appear both in the region of wall displacements and in the region of the rotation of magnetization vectors. The anelastic character of the effect is confirmed by measuring the dependence of the effect on the frequency of the field and on torsional oscillations; the relaxation time onthe effect is determined by the circular frequency of the alternating magnetic field. The different aspects of the effect are discussed and a possible way of calculating the effect is indicated.

539.2 : 538.2

13815 PIEZOMAGNETISM IN THE ANTIFERROMAGNETIC FLUORIDES OF COBALT AND MANGANESE.
A.S.Borovik-Romanov.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1954-5 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1390-1 (Dec., 1959).

The magnetic symmetry of CoF_2 and MnF_2 permits the occurrence of a piezomagnetic effect although it has not been observed hitherto. The present experiments, conducted at 20.4°K, showed the existence of the effect in CoF_2 when a pressure of ~ 500 kg/cm^2 was used. The magnitude was approximately 110 gauss per mole. In fields up to 500 Oe the direction of the piezomagnetic moment remains unchanged but in large fields oppositely directed to the spontaneous moment the specimen magnetization reverses. The reversal is slow, some 15-20 minutes being required for equilibrium in a field of 1100 Oe. A similar effect but of only one hundredth the magnitude was found in MnF_2. F.E.Hoare

539.2 : 538.2 : 537.311

13816 ANISOTROPY OF THE GALVANOMAGNETIC EFFECT IN A CRYSTAL OF N-TYPE GERMANIUM AT TEMPERATURES OF THE TRANSITIONAL REGION OF CONDUCTIVITY.
R.G.Annaev and A.Allanazarov.
Dokl. Akad. Nauk SSSR, Vol. 132, No. 3, 557-60 (May 21, 1960). In Russian.

Results are plotted for longitudinal and transverse magnetoresistance, with magnetic fields up to 4500 gauss along [001], [110], [111] directions, in the temperature range 0°-95°C. A crude analysis uses "effective" values of the parameters appropriate to intrinsic n-type behaviour. An "effective" mobility is found to vary as $T^{-1.49}$ above 50°C. I.D.C.Gurney

539.2 : 538.2

13817 SYMMETRY OF MAGNETOSTRICTIVE PROPERTIES OF CRYSTALS. L.A.Shuvalov and B.A.Tavger.
Kristallografiya, Vol. 3, No. 6, 756-8 (Nov.-Dec., 1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 765-8 (Jan., 1960).

Magnetostriction coefficients are treated as a fourth order tensor relating deformation of a magnetic material to intensity of magnetization. A table is given of the form of this tensor and the number of its independent components for different crystal types. R.Parker

539.2 : 538.2

13818 THERMAL EXPANSION AND MAGNETOSTRICTION OF PYRRHOTITE. K.P.Belov and A.V.Zalesskii.
Krystallografiya, Vol. 3, No. 3, 388-9 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 390-2 (May-June, 1958).

Measurements were made by means of a recording wire extensometer. Curves are given showing the variation with temperature of the specific magnetization in a 4760 Oe field, the magnetostriction in an 1880 Oe field, the relative elongation, and the linear coefficient of expansion α, for t = 0 to 350°C. At t = 320°C, the curve for the elongation has a sharp break and the curve for α a sharp maximum. The forms of the curves are discussed and it is concluded that the energy of ordering of vacancies is greater than the energy of ordering of spins. S.Weintroub

539.2 : 538.2

13819 THE AMPLITUDE OF THE DIFFUSION AFTER-EFFECT AS A FUNCTION OF THE CONCENTRATION OF SOLID SOLUTIONS OF IRON—CARBON. P.Brissonneau.
J. Phys. Radium, Vol. 20, No. 2-3, 244-6 (Feb.-March, 1959). In French.

The experimental data on the magnetic diffusion after-effect can be simply interpreted by using the concept of an after-effect field. This field has been measured on various samples of pure iron containing known concentrations of carbon. In accordance with theory, the after-effect is proportional to the concentration of carbon in solid solution, the carbon forming a precipitate having no influence at all. Inversely, one can use the measurement of the after-effect field to determine the solubility limit of carbon in α-iron at various temperatures.

539.2 : 538.2

13820 MAGNETIC AFTER-EFFECT IN IRON DUE TO MOTION OF DISLOCATIONS.

G.Biorci, A.Ferro and G.Montalenti.
Phys. Rev., Vol. 119, No. 2, 653-7 (July 15, 1960).

The magnetic after-effect in iron at high temperatures due to motion of dislocations is investigated. The specimens, consisting of a few large crystals, are examined, some after a careful annealing and some after a small plastic deformation. The intensity of the after-effect is measured as the horizontal displacement (viscosity field) between two magnetization curves: one taken immediately after demagnetization, and the other taken a long time later. On annealed Armco iron the magnetic viscosity begins to appear above 320°C, reaching 0.3 amp-turn/m at about 450°C. On the other hand, in cold worked specimens the viscosity field is appreciably larger and is already observable below 200°C. Similar results are obtained on high-purity electrolytic iron. Comparison with the relaxation of elastic modulus, occurring in the same temperature range, seems to confirm that the observed magnetic viscosity is due to dislocation motion. An interpretation of the phenomenon is given on the basis of the Vicena theory concerning the dependence of the coercive force on the dislocation density.

539.2 : 538.2

13821 EDDY-CURRENT AND SPIN-RELAXATION LOSSES IN THIN METAL STRIPS AT FREQUENCIES UP TO ABOUT 1 Mc/s. R.Boll.

Z. angew. Phys., Vol. 12, No. 5, 212-23 (May, 1960). In German.

Measurements are reported of the complex permeability of nickel iron alloys in the form of thin sheets in the frequency range up to 1 Mc/s, and a unified theory of the frequency dependent parts of the loss factors is developed. An analysis of the experimental results reveals that the loss anomalies are only partly explained by "anomalous eddy-currents" arising from the domain structure of the materials; losses arise also from spin relaxation processes. The two types of loss may be separated by their different dependence upon sheet thickness. Since eddy-current losses become less important with decreasing sheet thickness, a new "threshold frequency" is defined above which losses are determined principally by spin relaxation. The measurements show that with thin strips the threshold frequency tends to a value which is entirely dependent upon spin relaxation processes. This frequency agrees with the gyromagnetic frequency introduced by Snoek for the description of losses in ferrites. Because of the higher saturation magnetization metals show higher permeabilities than ferrites at high frequencies. R.Parker

539.2 : 538.2

13822 FERRITES HAVING HYSTERESIS LOOPS ANNEALED BY HEAT TREATMENT IN A WEAK MAGNETIC FIELD.

A. de Kienlin, M.Kornetzki and H.Rabl.
J. Phys. Radium, Vol. 20, No. 2-3, 247-50 (Feb.-March, 1959). In French.

Magnetic materials of the Perminvar type display anomalous hysteresis loops if they have been annealed in a weak magnetic field. The form of the loops is asymmetric if annealing is carried out in a static field. All loop forms found can be explained by assuming that the domain walls are stabilized in the position which they occupy during annealing under the influence of the applied magnetic field.

539.2 : 538.2

13823 SOME OBSERVATIONS OF BITTER PATTERNS ON POLYCRYSTALLINE "SQUARE LOOP" FERRITES, AND A THEORETICAL EXPLANATION OF THE LOOP SHAPE AND PULSE CHARACTERISTICS OF THE MATERIAL. J.E.Knowles.

Proc. Phys. Soc., Vol. 75, Pt 6, 885-97 (June, 1960)

Before advancing any theory concerning the "squareness" or switching characteristics of a "square loop" ferrite it is necessary to assume a model for the domain (or rotational) configuration. In an attempt to obtain a knowledge of this configuration experimentally, observations were made of Bitter patterns on polycrystalline magnesium—manganese ferrite. A technique was developed which enabled the progress of a magnetization reversal to be followed in a single grain of the material. As a result of these observations it was postulated that the magnetization in each grain of the polycrystalline material lay along a [111] direction, and that the magnetization reversed by the motion of 180° domain walls. Hysteresis loops and pulse shapes calculated on the basis of this model showed a close resemblance to the experimental curves.

539.2 : 538.2

13824 THEORY OF THE MAGNETIC PROPERTIES OF FERRITE SINGLE CRYSTALS. A.A.Gusev.

Kristallografiya, Vol. 4, No. 5, 695-701 (Sept.-Oct., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 655-62 (May, 1960).

The quantum-mechanical problem of the double-sublattice ferrite-like single crystal with arbitrary spin and magnetic moment of the ions in the sublattices and arbitrary cationic distribution is solved in the quasi-classical approximation. The equilibrium distributions of the magnetic moments of the sublattices and the dependen of magnetization on the magnetic field in the region of strong and very strong fields are obtained.

539.2 : 538.2

13825 THE POLARIZATION OF NUCLEI IN NON-METALLIC FERROMAGNETICS. G.R.Khutsishvili.

Zh. eksper. teor. Fiz., Vol. 38, No. 5, 1647-9 (May, 1960). In Russian.

A method used for polarizing the nuclei in ferromagnetic metals (Abstr. 625 of 1957) is now suggested for non-metallic ferromagnetic The method consists of applying an external magnetic field, greater than the saturation field, to a specimen cooled to very low temperatures. Verbal reasoning, based on two models by Néel, is employed to show that polarization is produced in (1) ferrites with spinel structure, (2) ferromagnetic garnets. No experiments are described, but several possible applications are mentioned. N.Davy

539.2 : 538.2

13826 A CONTRIBUTION TO STUDYING THE MECHANISM OF PERMEABILITY DISACCOMMODATION IN FERRITE

S.Krupička and R.Gerber.
Czech. J. Phys. Vol. 10, No. 2, 158-60 (1960).

Experiments were carried out on a manganese ferrite ($Mn_{0.983}Fe_{1.993}O_4$) in both a finely powdered and a compact sintered form. For the compact form, disaccommodation was observed in two distinct temperature regions (-80°C and 0°-90°C) but for the powdered sample disaccommodation was found only at liquid nitrogen temperatures. An explanation of these effects is given on the basis that the disaccommodation is connected with the displacement of Bloch walls, the contribution of rotational processes being negligible D.J.Oliver

539.2 : 538.2

13827 MAGNETIC PROPERTIES OF Al, Ga AND Cr SUBSTITUTED GARNET FERRITES.

G.Villers, R.Pauthenet and J.Loriers.
J. Phys. Radium, Vol. 20, No. 2-3, 382-7 (Feb.-March, 1959). In French.

The influence of substituting Al^{3+}, Ga^{3+} and Cr^{3+} ions for Fe^{3+} ions on the magnetic properties of yttrium, gadolinium, dysprosium and erbium garnets is studied. An interpretation of the results obtained is given.

539.2 : 538.2

13828 THE MAGNETOCRYSTALLINE ANISOTROPY OF GALLIUM AND ALUMINIUM SUBSTITUTED MAGNETIT

R.F.Pearson.
J. Phys. Radium, Vol. 20, No. 2-3, 409-13 (Feb.-March, 1959).

Values of K_1, the first order anisotropy constant, have been measured by torque methods from 120°K to 400°K for seven crystals of gallium or aluminium substituted magnetite. The ionic distribution in these crystals has been carefully determined from other physical and chemical measurements and a preliminary analysis has been made of the results to decide the relative importance of the mechanism contributing to the anomalous variation of the anisotropy energy in magnetite.

539.2 : 538.2

13829 SUBSTITUTION IN HEXAFERRITES OF THE Fe^{3+} ION BY Al^{3+}, Ga^{3+}, Cr^{3+}.

E.F.Bertaut, A.Deschamps, R.Pauthenet and S.Pickart.
J. Phys. Radium, Vol. 20, No. 2-3, 404-8 (Feb.-March, 1959). In French.

The absolute magnetization, the parameters of the unit cell and the Debye—Scherrer intensities have been studied in the compounds BaO. (6-x) Fe_2O_3. xM_2O_3 where M = Al, Ga, Cr in order to determine the distribution of the M atoms on the crystallographic sites 2a, 2b, $4f_1$, $4f_2$ and 12k of the space group P6/mmc. Neutron diffraction shows the anisotropy direction to be c and confirms the Gorter mode which is one of 3 possible spin arrangements.

539.2 : 538.2

13830 THE ELECTRICAL AND GALVANOMAGNETIC PROPERTIES OF LITHIUM FERRITE-CHROMITE EAR THE COMPENSATION POINT.

P.Belov, A.N.Goryaga, Lin Chzhan-Da [Ling Chang-Ta].
h. eksper. teor. Fiz., Vol. 38, No. 6, 1914-15 (June, 1960). In ussian.

It is found that the longitudinal magnetoresistance changes gn just above the compensation point for the ferrite $i_2O.2.5Fe_2O_3.2.5Cr_2O_3$. A break in $d\rho/dT$ at the compensation oint is also found. It is suggested that these changes are connected ith the change in the influence of the tetrahedral and octahedral agnetic sublattices. M.E.Priestley

539.2 : 538.2

13831 EXPERIMENTAL RESULTS ON THE QUENCHING OF THE MAGNETIC MOMENT OF THE RARE EARTH ION IN ARNETS. R.Pauthenet.

Phys. Radium, Vol. 20, No. 2-3, 388-92 (Feb.-March, 1959). In rench.

One is led to assume that the orbital magnetic moment of the are earth ions in ferrimagnetic garnets is quenched at low temperare. By comparing experimental results on gallates and ferrites ith the behaviour of the Gd^{3+} ion, the importance of this effect for y^{3+}, Er^{3+} and Yb^{3+}, and its dependence on the temperature and the agnetic field, are shown. In addition, the results on Gd^{3+} give a rther proof of the validity of the molecular field model for ferrites.

539.2 : 538.2

13832 MAGNETIC SUSCEPTIBILITY OF SOME ROCK FORMING SILICATE MINERALS SUCH AS AMPHIOLES, BIOTITES, CORDIERITES AND GARNETS. Y.Syono.

Geomagn. Geoelect., Vol. 11, No. 3, 85-93 (1960).

Some silicate minerals such as amphiboles, biotites, cordierites nd garnets were examined magnetically. Magnetic susceptibility at he room temperature of garnets is in good agreement with the heoretical value estimated by using the effective Bohr magneton umber empirically from salts bearing above magnetic ions, while n the case of amphiboles, biotites and cordierites, which contain ater in their crystal structure, magnetic susceptibility at the oom temperature shows fairly larger value than expected.

539.2 : 538.2

13833 MAGNETIC-DIPOLE INDUCED NORMAL MODE IN GADOLINIUM IRON GARNET. J.I.Kaplan.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 335-6 (Oct., 1959).

The magnetic dipole anisotropy should allow information about he intra-sublattice exchange fields to be obtained by resonance methods. An expression is given for the resonance frequency of a sublattice mode. The observation of such resonances has been discussed previously. D.J.Oliver

539.2 : 538.2

13834 FEATURES OF MAGNETIC HYSTERESIS PHENOMENA IN THE SYSTEMS $Pr_2O_3.Fe_2O_3$ AND $La_2O_3.Fe_2O_3$.

K.P.Belov, M.A.Zaitseva and A.M.Kadomtseva.
Zh. eksper. teor. Fiz. Vol. 37, No. 4(10), 1159-61 (Oct., 1959). n Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 825-6 (April, 1960).

These ferrites have a perovskite structure and both show the so-called thermo-remanence effect whereby the magnetization—emperature curves plotted in a heating period differ from those btained in the subsequent cooling. The hysteresis effects in these errites were investigated, in fields up to 7500 Oe, in their initial tate and after cooling in the magnetic field from the Curie point. The latter treatment introduced large asymmetry in the hysteresis oops which were shifted upwards along the magnetization axis. It s suggested that there is a very large coercive force for these errites which would explain the observed effects. F.E.Hoare

539.2 : 538.2

13835 MAGNETIC AND RESONANCE PROPERTIES OF YTTRIUM FERRITE-GARNETS WITH REPLACEMENT OF Fe^{3+} IONS BY Cr^{3+} AND Al^{3+}.

K.P.Belov, M.A.Zaitseva and L.A.Malevskaya.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1602-3 (May, 1959). In Russian. English translation in: Soviet Physics--JETP (New York), Vol. 36(9), No. 5, 1138-9 (Nov., 1959).

The results for the spontaneous magnetization and Curie point agree with previous work (Abstr. 5451-2 of 1947). The line width for the Cr-substituted ferrites increased with concentration whilst for the Al-substituted ferrites a decrease was observed. The results for Al^{3+} are in agreement with theory (Abstr. 2996 of 1956) but the results for Cr^{3+} are not. D.J.Oliver

539.2 : 538.2

13836 SUBSTITUTIONAL INCORPORATION OF DIVALENT IRON IN YTTRIUM IRON GARNET.

R.A.Lefever and A.B.Chase
J. chem. Phys., Vol. 32, No. 5, 1575-6 (May, 1960).

Evidence is presented that divalent iron is incorporated in the structure through a mechanism involving silicon. Addition of small concentrations of silicon to melts prepared from materials of exceptionally high purity produces a low temperature peak in ferrimagnetic line widths exhibited by yttrium iron garnet crystals. The effect is most likely the result of divalent iron in the structure.
J.Adam

539.2 : 538.2

13837 SPIN WAVES IN VARIOUS FERRIMAGNETIC SUPERSTRUCTURES. I. TRANSLATION LATTICES WITH TWO KINDS OF SPINS. H.Cofta.

Acta phys. Polon, Vol. 18, No. 3, 215-29 (1959).

A new classification of superstructures is given, introducing the definitions of natural order and regular orders. By means of a semiclassical approach the general dispersion formula for spin-waves frequency is derived, taking into account interactions with all neighbours in any regular spin order of translation lattice with two kind of spins and comprising also ferromagnetism and antiferromagnetism. In the special cases the derived formula agrees entirely with those of other papers, based on semiclassical theory. The kinematical method of Keffer, Kaplan and Yafet (Abstr. 4201 of 1953) is generalized and its equivalence with formal calculations is shown. The picture of spin precession waves in ferrimagnetic translation lattices with two kinds of spins is investigated. The analysis of non-regular superstructures leads to an interesting consequence for antiferromagnetics. It appears that simple antiferromagnetic sublattices in body centred non-regular superstructures must be mutually uncoupled. This result is confirmed for an MnO_2 crystal.

539.2 : 538.2

13838 SOME RECENT PROGRESS IN THE THEORY OF MAGNETISM FOR NON-MIGRATORY MODELS.

J.H.Van Vleck.
J. Phys. Radium, Vol. 20, No. 2-3, 124-35 (Feb.-March, 1959).

Reviews the progress made since 1950 by various workers in calculating the Curie point for the Heisenberg model and the behaviour of the susceptibility above it. The calculations have been greatly improved in recent years by including more terms in the series method, and in extending both this method and that of Bethe—Peierls--Weiss to higher values of the spins. Furthermore, the B—P—W theory has been applied to ferrimagnetism, and especially to antiferrimagnetism where it gives both the Neel point and the corresponding maximum value of the susceptibility. The so-called constant coupling approximation of Kasteleijn and Van Kranendonk is a relatively simple method which gives surprisingly good results for three-dimensional lattices (see Abstr. 5210 of 1956). Recent developments are reviewed in the calculation of the magnetization at very low temperatures by the method of spin waves. Ferromagnetic anisotropy is studied. It is necessary to generalize the Heisenberg model by including spin—orbit interaction, since otherwise no anisotropy results. A general proof is given that with quadrupole type coupling, the cubic anisotropy constant K_1 should vary as the tenth power of the magnetization a low temperatures. In ferrites a "one-atom" model of the anisotropy can be used, but in ferromagnetic materials where the spins of the individual atoms are 3/2 or less it is necessary to include coupling between atoms to obtain appreciable anisotropy. The temperature variation of the magnetic anisotropy of nickel is still a mystery. On the other hand, crystalline field theory furnishes an explanation of the unusually large anisotropy of dilute cobalt ferrites.

539.2 : 538.2

13839 SOME FERRIMAGNETIC AND ANTIFERROMAGNETIC MATERIALS AT LOW TEMPERATURES.

R.M.Bozorth and V.Kramer.
J. Phys. Radium, Vol. 20, No. 2-3, 393-401 (Feb.-March, 1959).

The magnetization of single crystals and of polycrystals of a number of materials has been investigated at temperatures from 1.3 to 300°K, in fields up to 12 500 Oe. Measurements were made on single crystals of $LiMnPO_4$ (orthorhombic), $Fe_3(PO_4)_2.4H_2O$ (monoclinic), and $HoFeO_3$ (orthohombic); polycrystalline materials were $HoFeO_3$, Ho_2O_3, and Er_2O_3, $PbO . Fe_{12-x}Al_xO_{18}$, $FeTiO_3$ and $FeTiO_3$-Fe_2O_3 solid solutions, CoMnO and $NiMnO_3$, $CuF_2 .2H_2O$, MnF_3, and CrF_3. The ferromagnetic single crystals show spontaneous magnetization along one crystallographic direction; in $Fe_3(PO_4)_2 . 4H_2O$ it was not possible to rotate the spontaneous magnetization out of the direction of the axis, in $HoFe_3O$ it is readily rotated away from the preferred orthohombic axis at low temperatures. The spontaneous magnetization in $HoFeO_3$ rises to about 3 Bohr magnetons as the temperature is lowered.

539.2 : 538.2

13840 TRIGONAL MAGNETOCRYSTALLINE ANISOTROPY IN HEXAGONAL OXIDES.

L.R.Bickford Jr.

Phys. Rev., Vol. 119, No. 3, 1000-9 (Aug. 1, 1960).

Torque measurements of the magnetocrystalline anisotropy between 77°K and 300°K are reported for single crystals of two different ferrimagnetic oxides having structures related to that of the mineral magnetoplumbite. The compounds with chemical compositions $Co_2Ba_2Fe_{12}O_{22}$ and $Co_2Ba_3Fe_{24}O_{41}$, are known as Co_2Y and Co_2Z, respectively. Both compounds, after suitable magnetic field cooling treatment, display trigonal anisotropy in the basal plane at 77°K. The field cooling is shown to have the effect of placing the magnetization into one of two energetically equivalent orientations, each of which leads to a trigonal term of different sign. Examination of the crystal structures shows that in the case of Co_2Y an additional term $K_2' \sin^3\theta \cos\theta \cos 3\varphi$ (where θ and φ are the polar coordinates of the magnetization) should be added to the generally accepted phenomenological hexagonal anisotropy expression. The anisotropy constant K_2' is evaluated as 6×10^5 erg/cm^3 at 117°K. In the case of Co_2Z this trigonal anisotropy term is not consistent with the crystal symmetry, although it is appropriate for structural subgroups of the unit cell. Its trigonal anisotropy is explained in terms of a "puckered" magnetization pattern whereby the sign of the c-axis component of magnetization is different for adjacent subgroups. The existence of this puckered pattern implies that the exchange coupling across the boundaries between subgroups is relatively weak. A new rotational hysteresis effect in Co_2Y is described and explained phenomenologically. An atomic theory assigning the origin of the trigonal anisotropy of both compounds to the cobalt ions is presented.

539.2 : 538.2

13841 AN EXCHANGE ANISOTROPY MEMORY EFFECT.

I.S.Jacobs and P.E.Lawrence.

J. appl. Phys., Vol. 31, No. 8, 1388-91 (Aug., 1960).

A magnetic memory effect is observed in a low Curie point ferrimagnetic spinel ($\sim NiFe_{0.15}Cr_{1.85}O_4$) containing a coherent antiferromagnetic impurity (NiO) with a high Néel point. It is explained in terms of the Meiklejohn—Bean exchange anisotropy coupling the two phases (Abstr. 4525 of 1957). The past magnetic history is remembered in the spontaneous reacquisition of a fraction of the past remanent state despite prolonged storage at temperatures above the ferrimagnetic Curie point. A feature of the explanation is the condition that antiferromagnetic domains in NiO rotate irreversibly in accessible fields.

539.2 : 538.2

13842 LINEAR ANTIFERROMAGNETIC CHAIN.

T.W.Ruijgrok and S.Rodriguez.

Phys. Rev., Vol. 119, No. 2, 596-9 (July 15, 1960).

The properties of the low-lying states of the antiferromagnetic chain are studied by means of a variational method. A trial wave-function is exhibited which has an energy very close to that of the correct ground state and which displays a long-range order.

539.2 : 538.2

13843 ANTIFERROMAGNETIC COUPLING AND COVALENT BONDING IN ALMOST TOTALLY IONIC SALTS.

T.R.Waite.

J. chem. Phys., Vol. 33, No. 1, 256-65 (July, 1960).

Anderson (Abstr. 12464 of 1959) has presented an analysis of antiferromagnetic coupling in salts. His results are derived and extended by an alternate, more physical method. The problem of antiferromagnetism in salts is the problem of spin—spin coupling between two magnetic cations separated by an intervening anion. A linear three-ion array (in the presence of the rest of the crystal) is considered from the viewpoint of molecular orbital theory. In anticipation of electron—electron correlation, and in order to associate each electron spin with only one cation, the molecular orbitals are relocalized. Configuration interaction is small and may be treated by perturbation theory. The perturbation matrix is defined in terms of this representation rather than as a real physical part of the Hamiltonian. The cation—cation spin coupling terms appear as isolated, additive perturbing terms. The expansion parameter is the percent covalent character of the anion—cation bond. Coupling is antiferromagnetic for cations with from five to eight d electrons. Parameters may be estimated from (1) crystal field splittings and/or (2) hyperfine interaction between magnetic electro and anion nuclei. The perturbed ground state wave-function is reduced to a single Slater determinate involving nonorthogonal one-electron wave-functions, thereby revealing the physical cause of the coupling. Since no cation—cation coupling occurs in zero order with localized orbitals, the spin functions can be constructed from eigenfunctions of the individual cation spin operators using Clebsch—Gordon series. The coupling energy is of the form $K_{ij}S_i.S_j$ where S_i is the total vector spin of cation i in the zero-order representation.

539.2 : 538.2

13844 THE TRANSITION IN CHROMIUM AND IN SOME ALLOYS OF CHROMIUM WITH SMALL AMOUNTS OF OTHER TRANSITION ELEMENTS.

G.De Vries.

J. Phys. Radium, Vol. 20, No. 2-3, 438-9 (Feb.-March, 1959).

The transition in chromium at 38°C is investigated by measurin the influence on the electrical resistance and the Hall effect of alloying with about 1 at. % of V, Mn, Fe, Co or Ni. The results prove the electronic nature of the transition and give an indication o the identity of the 38°C transition with the Néel point.

539.2 : 538.2

13845 PRINCIPAL MAGNETIC SUSCEPTIBILITIES OF COBAL CHLORIDE, BROMIDE AND IODIDE.

H.Bizette, C.Terrier and B.Tsai.

J. Phys. Radium, Vol. 20, No. 2-3, 421-3 (Feb.-March, 1959). In French.

Below Tλ, the direction of antiferromagnetism is perpendicular to the crystal axis in $CoCl_2$ and $CoBr_2$, and parallel to this axis in CoI_2. The susceptibility $\chi_{\perp}$ of CoI_2 increases as the temperature decreases below Tλ.

539.2 : 538.2

13846 ELASTICITY AND ANTIFERROMAGNETISM OF METALLIC ANTIFERROMAGNETICS.

R.Street and J.H.Smith.

J. Phys. Radium, Vol. 20, No. 2-3, 82-7 (Feb.-March, 1959).

If an antiferromagnetic is spontaneously deformed on cooling through the Néel temperature, then the application of an external stress results in a redistribution of domain vectors, e.g. they may rotate or antiferromagnetic domain walls may move. This causes an additional strain component which will be apparent as an anomalous variation of the Young's modulus with the temperature. The results of measurements of the temperature dependence of Young's modulus for antiferromagnetic γ-CuMn alloys and mixed phase $(\alpha + \gamma)$ CuMn alloys are reported. The $(\alpha + \gamma)$ alloys show (a) a Young's modulus variation of the expected form which is due to the contained α-Mn, (b) a Young's modulus anomaly at about 130°K associated with the precipitated γ-CuMn (containing 40 at.% Mn). It is shown that the latter phase below 130°K exhibits ferromagnetic characteristics. A smooth temperature variation of Young's modulus has been obtained for Pd which is consistent with the assumption that Pd is not antiferromagnetic at low temperatures.

539.2 : 538.2

13847 MAGNETIC PROPERTIES OF DILUTE ALLOYS. MAGNETIC INTERACTIONS AND ANTIFERROMAGNETISM IN ALLOYS OF THE TYPE NOBLE METAL—TRANSITION METAL.

A.Blandin and J.Friedel.

J. Phys. Radium, Vol. 20, No. 2-3, 160-8 (Feb.-March, 1959). In French.

The electronic structure of disordered alloys of a transition element at low concentrations is investigated and a classification of their magnetic properties is obtained. A model of magnetic interaction between impurities is proposed to explain the antiferromagnetic properties of some such alloys (Cu—Mn).

539.2 : 538.2

13848 MAGNETIC PROPERTIES OF THE IRON-GROUP ANHYDROUS CHLORIDES.

J.Kanamori.

Progr. theor. Phys., Vol. 20, No. 6, 890-908 (Dec., 1958).

The magnetic properties of $FeCl_2$ are investigated in detail from the standpoint of the one-ion approximation. The lowest orbita state of the ferrous ion in the crystalline field of trigonal symmetry is assumed to be doublet, in which the component of the orbital angular momentum along the trigonal axis is not quenched. The spin—orbit coupling energy produces a splitting of the spin levels b onging to the lowest doublet. In the vicinity of, or below, the N l temperature (24° K) where only the lowest spin level is popul- a d, one has effectively an Ising model, in which the x, y components o he spins are completely quenched. The metamagnetic behaviour o his substance at liquid hydrogen temperatures can be interpreted q e naturally by this model. The susceptibility near room tempera- t e is also discussed and it is shown that the paramagnetic Curie t perature is strongly modified by the large splitting of the spin l els due to the spin-orbit coupling energy. The crystalline field i calculated, and the result seems to support the assumed orbital l el scheme. $FeCO_3$, $CoCl_2$, $NiCl_2$, $FeBr_2$ and FeI_2 are also dis- c sed briefly.

539.2 : 538.2

13849 SINGLE CRYSTAL NEUTRON DIFFRACTION STUDIES OF ANTIFERROMAGNETS AT LOW TEMPERATURES I APPLIED MAGNETIC FIELDS.

C.Koehler, M.K.Wilkinson, J.W.Cable and E.O.Wollan.

Phys. Radium, Vol. 20, No. 2-3, 180-4 (Feb.-March, 1959).

The magnetic properties of a number of hexagonal layer-type c mpounds have been investigated by single crystal neutron dif- f ction methods at temperatures down to 1.35° K and with magnetic f lds up to 16.3 kOe applied to the sample. The antiferromagnetic s ucture of $MnBr_2$ ($T_N = 2.16°$ K) and its related domain trans- f mation properties, and the effect of an applied magnetic field on t antiferromagnetic structure of $FeCl_2$ ($T_N = 23°$ K) are described i some detail as illustrations of the techniques. Results for the a hydrous dibromides and dichlorides of Mn, Fe, and Co are s mmarized briefly.

539.2 : 538.2

13850 THE MAGNETIC SUSCEPTIBILITY OF AN MnO SINGLE CRYSTAL. T.R.McGuire and R.J.Happel, Jr.

Phys. Radium, Vol. 20, No. 2-3, 424-6 (Feb.-March, 1959).

The magnetic susceptibility of an MnO single crystal grown by f me fusion was found to be similar to the powder material; wever, the magnetic field dependence of the susceptibility was l rger than the dependence for the powder and in addition extended i o the paramagnetic region.

539.2 : 538.2

13851 ANTIFERROMAGNETIC SUPEREXCHANGE EFFECT. R.K.Nesbet.

ys. Rev., Vol. 119, No. 2, 658-62(July 15, 1960).

The delocalization effect proposed by Anderson (Abstr. 12464 of 59) as the principal contribution to the antiferromagnetic coupling magnetic ions is analysed by methods used in an earlier paper bstr. 5104 of 1958) to derive the Heisenberg exchange operator rmalism for both ferromagnetic and antiferromagnetic coupling. is shown that Anderson's effect can be included, together with the perexchange correlation effect treated previously, as contributions the Heisenberg exchange integral for ions of arbitrary spin. In the se of the antiferromagnetic oxides MnO, FeO, CoO, and NiO these o effects are found to be of comparable size, although the correla- n effect is larger and determines the qualitative behaviour of the el temperatures, which increase with decreasing spin through this quence of transition metal ions. Agreement with the experimental el temperatures is significantly improved by including both effects.

539.2 : 538.2

13852 ANTIFERROMAGNETISM IN NiF_2. R.A.Alikhanov.

h. eksper. teor. Fiz., Vol. 37, No. 4(10), 1145-7 (Oct., 1959). In ussian. English translation in: Soviet Physics — JETP (New ork), Vol. 37(10), No. 4, 814-16 (April, 1960).

New neutron diffraction experiments with increased resolution dicate that the magnetic moments lie in planes perpendicular to e tetragonal axis. The two sublattice vectors are rotated from tiparallelism in agreement with the weak ferromagnetism observed NiF_2. A.J.Manuel

539.2 : 538.2

13853 FERROMAGNETISM AND ANTIFERROMAGNETISM IN DISORDERED Ni—Mn ALLOYS.

S.Kouvel, C.D.Graham, Jr and I.S.Jacobs.

Phys. Radium, Vol. 20, No. 2-3, 198-202 (Feb.-March, 1959).

The magnetic properties of disordered Ni—Mn alloys between K and 300° K are found to be extremely sensitive to composition n the vicinity of Ni_3Mn). From hysteresis loops and magnetization ersus temperature curves for fields up to 8000 Oe, it is deduced at with increasing Mn concentration, the alloy becomes less ferromagnetic and more antiferromagnetic in its low temperature behaviour. Magnetization measurements for pulsed fields up to 100 000 Oe are consistent with the coexistence of ferromagnetism and antiferromagnetism in these alloys. This interpretation is further supported by the discovery that the hysteresis loop for the 26.5% Mn specimen cooled to 4.2° K in a magnetic field is shifted from its symmetrical position about the origin.

539.2 : 538 2

13854 ANTIFERROMAGNETISM OF THE ALLOY $Pd_3 Mn_2$. J.P.Burger, R.Wendling and J.Wucher.

J. Phys. Radium, Vol. 20, No 2-3, 427-9 (Feb.-March, 1959). In French.

In the disordered state the alloy Pd_3Mn_2 is antiferromagnetic. By appropriate annealing, one obtains a superstructure which presents a thermomagnetic remanence, related to the Néel point of the disordered state, at $t_c = 320°$ C: (1) σ_r is destroyed by heating above t_c. (2) Quenching in a magnetic field is effective only below t_c. See also Abstr. 10108 of 1960.

Magnetic Resonances

539.2 : 538.27

13855 ON THE LINE WIDTH IN FERROMAGNETIC RESONANCE. S.Takeno.

Progr. theor. Phys., Vol. 18, No. 4, 448-9 (Oct., 1957).

A suggestion that at least part of the temperature independent line-width in ferromagnetic resonance may be due to variation of the demagnetization factor with position within the sample as a result of domains, etc. J.G.Powles

539.2 : 538.27

13856 ELECTROMAGNETIC THEORY OF D.C. EFFECTS IN FERROMAGNETIC RESONANCE. H.J.Juretschke.

J. appl. Phys., Vol. 31, No. 8, 1401-6 (Aug., 1960).

Effects of magnetoresistance and extraordinary Hall effect on the propagation of electromagnetic waves through very thin sheets of ferromagnetic conductors are studied. These contributions to the conductivity produce electric fields varying like products of current and magnetization and introduce nonlinear interactions, which are particularly large in the neighbourhood of ferromagnetic resonance. Detailed first-order d.c. electric fields are obtained for the configuration of a very thin ferromagnetic sheet very close to a conducting wall. The results predict signals strictly proportional to incident microwave power, and mostly inversely proportional to film thickness, becoming independent of thickness for the thinnest films. Their magnetic field or frequency dependence gives typical resonance curves modulated by slowly varying amplitudes. The maxima and zeros of these amplitudes are very sensitive to the local field configuration. Once this latter is well known, however, these effects can be employed to study conveniently the high-frequency conduction and magnetic properties of the thinnest films.

539.2 : 538.27

13857 INFLUENCE OF HETEROGENEITIES ON THE FERROMAGNETIC RESONANCE IN METALS.

W.Döring and H.Vial.

Z.Naturforsch., Vol. 15a, No. 5-6, 434-47 (May-June, 1960). In German.

The effects of finite crystal size and surface roughness are investigated theoretically for the two cases where the size of the disturbance is less or greater than the skin depth. E.P.Wohlfarth

539.2 : 538.27

13858 FERROMAGNETIC RESONANCE IN POLYCRYSTALS. E.Schlömann.

J. Phys. Radium, Vol. 20, No. 2-3, 327-32 (Feb.-March, 1959).

The theory of ferromagnetic resonance in polycrystalline material is developed for the two cases in which the anisotropy field is either very large or very small compared with the saturation magnetization. Experimental results obtained with cubic and hexagonal ferrites of large anisotropy agree reasonably well with the theory.

539.2 : 538.27

13859 VARIATION OF THE g-FACTOR AND THE ABSORPTION LINE WIDTH ΔH_a OF YTTRIUM GARNETS SUBSTITUTED WITH ALUMINIUM. A.J.Berteaud, G.Villers and J.Loriers.

C.R.Acad. Sci. (Paris), Vol. 250, No. 23, 3807-9 (June 8, 1960). In French.

Reports results for $(5 - x)Fe_2O_3.xAl_2O_3.3Y_2O_3$; ΔH_a was found to have a maximum at x about 0.5 (depending on the temperature of preparation) and to decrease to low values at x = 1.5. Results above 1.5 were obtained at 80° K and ΔH_a was found to have a minimum near this value of x. E.P.Wohlfarth

539.2 : 538.27

13860 MICROWAVE RESONANCE IN THIN FERROMAGNETIC FILMS. P.E.Tannenwald and M.H.Seavey, Jr.

J. Phys. Radium, Vol. 20, No. 2-3, 323-6 (Feb.-March, 1959).

Thin films of permalloy have been investigated by microwave resonance techniques. The saturation magnetization has been measured as a function of thickness; harmonic generation has been considered. A theoretical analysis has been carried out of exchange effects in ferromagnetic resonance in thin films, and various criteria for observing such effects are compared with preliminary experimental results. A new phenomenon has been observed, in which a d.c. resonance signal is taken off two wires soldered to the film.

539.2 : 538.27

13861 EXCHANGE RESONANCES IN GADOLINIUM IRON GARNET AT 24 000 MHz.

S.Geschwind, L.R.Walker and D.F.Linn.

J. Phys. Radium, Vol. 20, No. 2-3, 344-8 (Feb.-March, 1959).

Ferrimagnetic resonance has been experimentally studied in single crystals of gadolinium iron garnet at 24 000 Mc/s in the vicinity of the magnetic compensation point at T_C = +13° C. The two modes of resonance corresponding to the normal and abnormal directions of precession of the coupled Fe and Gd sublattices were observed and the results compared with a theory which includes the effect of the susceptibility of the Gd. From these measurements, the exchange field at T_C was found to be 231 000 Oe, in excellent agreement with magnetization data. In addition, information on $(g_{Fe} - g_{Gd})$ and the crystalline anisotropy were obtained. In a one degree region around the compensation temperature, additional modes of resonance were observed. Each of these resonances corresponds to the Fe and Gd sublattices aligned along a (111) direction which is not parallel to the external magnetic field.

539.2 : 538.27

13862 FERRIMAGNETIC RESONANCE OF FERRITES AND GARNETS AT THE COMPENSATION TEMPERATURE.

J.Paulevé, B.Dreyfus and M.Soutif.

J. Phys. Radium, Vol. 20, No. 2-3, 355-9 (Feb.-March, 1959). In French.

A simple method is given for determining the resonance conditions of a ferrite with two sublattices, neglecting the anisotropy and relaxation terms. The method is applied to the study of resonance field variations in ferrites having a compensation temperature. Some results dealing with lithium—chrome ferrites and with erbium and gadolinium garnets are reported.

539.2 : 538.27

13863 HIGH FIELD ANTIFERRO-, FERRI- AND PARAMAGNETIC RESONANCE AT MILLIMETER WAVELENGTHS. S.Foner.

J. Phys. Radium, Vol. 20, No. 2-3, 336-40 (Feb.-March, 1959).

Pulsed magnetic fields have been employed to "tune" the high frequency magnetic interactions of antiferro- ferri- and paramagnetic systems to 4 mm and 7 mm wavelengths. Examples of resonance experiments for each of these magnetic systems are given, the nature of the information obtained is reviewed, and results of these experiments are summarized. Related magnetic measurements are also described; a detailed summary of susceptibility measurements for single crystal MnF_2, CoF_2 and Cr_2O_3 is given. Applications to high frequency devices are indicated.

539.2 : 538.27

13864 $MnAu_2$ MAGNETIC RESONANCE. G.Asch.

J. Phys. Radium, Vol. 20, No. 2-3, 349-51 (Feb.-March, 1959). In French.

Magnetic resonance of polycrystalline $MnAu_2$ has been observed at 9300 Mc/s and 35 630 Mc/s between −100° C and +140° C. The resonance observed in the antiferromagnetic state is explained by antiferromagnetic resonance theory applied to the model of $MnAu_2$ given by Néel.

539.2 : 538.27 : 530.16

APPROACH TO EQUILIBRIUM IN QUANTAL SYSTEMS: MAGNETIC RESONANCE. See Abstr. 12378

539.2 : 538.2

13865 ON THE SPIN—LATTICE RELAXATION PROCESS IN FERROMAGNETS. F.Terasaki and I.Mannari.

Progr. theor. Phys., Vol. 18, No. 5, 552-4 (Nov., 1957).

The exchange integral is regarded as modulated by phonons an to depend exponentially on interatomic distance. The room-temper ture relaxation time for this process is calculated to be 2×10^{-11} s for nickel. E.P.Wohlfart

539.2 : 538.2

13866 MODULATION-EFFECT CORRECTIONS FOR MOMEN OF MAGNETIC RESONANCE LINE SHAPES. K.Halbach

Phys. Rev., Vol. 119, No. 4, 1230-3 (Aug. 15, 1960).

Corrections are derived for the calculation of the second and fourth moments of magnetic resonance lines from experimental dat obtained by using the low-frequency modulation method. The resul for 0° phase shift between field modulation and the lock-in referenc are

$$\langle \Delta\omega_{\exp}{}^2 \rangle Av = \langle \Delta\omega^2 \rangle Av + \tfrac{1}{3}\omega_M{}^2 + \tfrac{1}{4}(\gamma H_M)^2,$$

$$\langle \Delta\omega_{\exp}{}^4 \rangle Av = \langle \Delta\omega^4 \rangle Av + \langle \Delta\omega^2 \rangle Av\,[2\omega_M{}^2 + \tfrac{3}{2}(\gamma H_M)^2] + + \tfrac{1}{5}\omega_M{}^4 + \tfrac{3}{4}\omega_M{}^2(\gamma H_M)^2 + \tfrac{1}{8}(\gamma H_M)$$

Furthermore, it is found that no corrections are necessary for the calculation of intensities despite distortion of the line shape resulti from modulation effects. The equivalence of field and frequency modulation is proved for signals describable by Bloch's equations and the discussion of the general case strongly supports the genera validity of this equivalence.

539.2 : 538.

13867 ELECTRON SPIN RESONANCE INTENSITY IN ANISOTROPIC SUBSTANCES. B.Bleaney.

Proc. Phys. Soc., Vol. 75, Pt 4, 621-3 (April, 1960).

The e.s.r. line shape expected in a polycrystalline sample wit anisotropic g-values is discussed, allowance being made for the chan in transition probability with orientation of the oscillatory magneti field which induces the transitions. The calculation is restricted t paramagnetic species when the g-factor has axial symmetry, and fine or hyperfine structure splittings are absent. J.M.Bak

539.2 : 538.2

13868 ELECTRONIC PARAMAGNETIC RESONANCE SPECTR OF FROZEN OH RADICALS.

S.D.Kaitmazov and A.M.Prokhorov.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1331-2 (Aug., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 4, 944 (Oct., 1959).

Reports electron spin resonance of radicals obtained by ultraviolet irradiation of hydrogen peroxide at 77° K at five frequencies between 12 000 and 850 Mc/s. It is proposed that the radicals are OH^-. J.G.Powle

539.2 : 538.2

13869 PARAMAGNETIC RESONANCE OF THE $Cr(H_2O)_6^{3+}$ COMPLEX IN A SINGLE CRYSTAL OF $Al(H_2O)_6Cl_3$.

G.Emch and R.Lacroix.

Arch. Sci (Geneva), Vol. 13, No. 1, 157-8 (Jan-March, 1960). In French.

A study of the Cr^{3+} e.s.r., presumably in the microwave regio and at room temperature, in dilute solution in a single crystal of aluminium chloride hexahydrate. The magnetic parameters have been obtained. It is found that there is some covalent bonding to the water molecules as in chrome alum. J.G.Powle

539.2 : 538.2

13870 THE TEMPERATURE-DEPENDENCE OF ELECTRON SPIN-LATTICE RELAXATION TIMES IN RUBY.

R.E.Michel.

J. Phys. Chem. Solids, Vol. 13, No. 1-2, 164-6 (May, 1960).

T_1 for Cr^{3+} in ruby at 9.3 kMc/s was measured by saturation for a particular transition and orientation in the range 77° to 300° for 0.65 and 0.055% Cr_2O_3. The results agree with the theory of Van Vleck (see Abstr. 1661 of 1940), but disagree with other measu ments (see Abstr. 9811 of 1959). J.G.Powl

539.2 : 538.

13871 PARAMAGNETIC-RESONANCE ABSORPTION OF ION WITH SPIN $\frac{5}{2}$: Mn^{++} IN CALCITE.

C.Kikuchi and L.M.Matarrese.

J. chem. Phys., Vol. 33, No. 2, 601-6 (Aug., 1960).

The theory of the paramagnetic-resonance absorption of ions $S = \frac{5}{2}$ in crystalline fields of trigonal symmetry is presented. case of manganous ions in calcite ($CaCO_3$) is taken as an example. s shown that the splitting of the fine-structure satellites into plets first reported by Hurd, Sachs and Hershberger (Abstr. 4 of 1954) can be accounted for by assuming that the manganous s can occupy the two nonequivalent Ca^{2+} sites at random. The kimum splitting was measured at X band and K band and found e 19.3 ± 0.5 G. The value computed from the theory, assuming onic model, is 23.8 G. In addition, five pairs of weak lines were nd, each pair occurring midway between adjacent hyperfine groups. origin of these lines is uncertain. The applicability of the sent theory to Al_2O_3:Fe, a zero-field maser material, and to the tosensitive Fe^{3+} centre in CdS is pointed out.

539.2 : 538.27

13872 PARAMAGNETIC RESONANCE OF CdTe:Mn AND CdS:Mn. J.Lambe and C.Kikuchi.

rs. Rev., Vol. 119, No. 4, 1256-60 (Aug. 15, 1960).

In CdTe, the lines are found to be very broad at 300° K; at K, the lines narrow sufficiently to measure parameters, with result g = 2.010, A = 0.0055 cm^{-1}, and 3a = 0.0084 cm^{-1}, where is the zero-field splitting. The superhyperfine splitting is the ne as for CdS with components spaced at 1.4 G giving d = 2.6 × 10^{-4} cm^{-1}. In CdS an interaction with conduction ctrons is found which can broaden the lines at 300° K. At low nperatures an anomalous spectrum is found in CdS with 0.0295 cm^{-1}.

539.2 : 538.27

13873 ELECTRON PARAMAGNETIC RESONANCE OF THE Ti^{3+} ION IN CORUNDUM.

.Kornienko and A.M.Prokhorov.

. eksper. teor. Fiz., Vol. 38, No. 5, 1651-2 (May, 1960). Russian.

The electron paramagnetic resonance absorption line of Ti^{3+} s, "isomorphically" introduced into three specimens of corundum stals, was obtained. It had an unusually asymmetric appearance h a sharper fall on the side of increasing magnetic field. Using expression for the spin Hamiltonian, numerical values of the two actors, $g_{\parallel}$ and $g_{\perp}$, were obtained. The relationship between the e width and the angle between the external magnetic field and trigonal axis of the electric field of the crystal, was studied, vealing a considerable divergence from the law $\Delta H = l\Delta\nu/g\beta$. e time of spin—lattice relaxation was determined, and showed narked dependence on temperature. No satisfactory theory of s has yet been proposed. N.Davy

539.2 : 538.27

13874 PARAMAGNETIC RESONANCE IN METALLIC EUROPIUM AND INTERMETALLIC COMPOUNDS.

Peter and B.T.Matthias.

ys. Rev. Letters, Vol. 4, No. 9, 449-50 (May 1, 1960).

A paramagnetic resonance with a g-value of 1.985 ± 0.015 was served in metallic europium. It was inferred that in the metal, ropium exists in the $^8S_{7\,2}$ state and hence that it is divalent, unlike other rare earths. No resonance was observed in $EuIr_2$, in which ropium is believed to be trivalent. E.F.W.Seymour

539.2 : 538.27

13875 RESONANCE TRANSITIONS IN PARALLEL FIELDS IN CERTAIN Mn^{++} AND Fe^{+++} SALTS. N.S.Garif'yanov.

. eksper. teor. Fiz., Vol. 36, No. 6, 1957-8 (June, 1959). In ssian. English translation in: Soviet Physics--JETP (New York), l. 36(9), No. 6, 1393 (Dec., 1959).

$\chi''(H)$ was measured at 9500 Mc/s and T = 295° K in $NH_4(SO_4)_2.12H_2O$ with an oscillating field applied at various gles θ with the constant field. As θ changes from 90° to 0° the ensity of the peak due to the transition $\Delta m = \pm 2$ increased by an der of magnitude whilst the intensity for $\Delta m = \pm 1$ decreased to ro. It is concluded that the maximum absorption $\chi''(H)$ observed eviously in parallel fields is caused by resonance. D.J.Oliver

539.2 : 538.27

13876 EXCHANGE INTERACTIONS IN ANTIFERROMAGNETIC SALTS OF IRIDIUM. J.Owen.

Phys. Radium, Vol. 20, No. 2-3, 138-40 (Feb.-March, 1959).

A summary is given of recent work at Oxford on direct measure-ent by paramagnetic resonance of superexchange between para-agnetic ions in crystals. The results for nearest neigbour pairs of Ir ions in K_2IrCl_6 and $(NH_4)_2IrCl_6$ are compared with the susceptibility and antiferromagnetic properties of these salts. The behaviour of groups of three coupled Ir ions is also discussed briefly.

539.2 : 538.27

13877 EFFECTS OF POLYTYPISM ON THE ELECTRON PARAMAGNETIC RESONANCES OF $K_3Co(CN)_6$ AND OTHER SPECTROSCOPIC IMPLICATIONS.

J.O.Artman, J.C.Murphy, J.A.Kohn and W.D.Townes.

Phys. Rev. Letters, Vol. 4, No. 12, 607-9 (June 15, 1960).

Recently, pure and doped (0.1% Cr) crystals of $K_3Co(CN)_6$ were found to be polytypic by single crystal X-ray diffraction. Slight differences in the principal values, and of the orientation of the principal directions of the g and crystal field tensors describing the e.s.r. of Cr^{3+} have been found for the two main polytypes containing 0.1% Cr. As different polytypes can coexist in a visually homogeneous crystal e.s.r. spectra for several polytypes may by superimposed. Polytypism may complicate the interpretation of magnetic susceptibility data, give rise to inhomogeneous e.s.r. lines, and provide data for a critical examination of the current methods of dealing with crystal field effects. J.M.Baker

539.2 : 538.27

13878 ELECTRON SPIN—LATTICE RELAXATION IN DILUTE POTASSIUM CHROMICYANIDE AT HELIUM TEMPERATURES. J.G.Castle, Jr, P.F.Chester and P.E.Wagner.

Phys. Rev., Vol. 119, No. 3, 953-61 (Aug. 1, 1960).

Measurements were made of the electron spin—lattice relaxation of the $-\frac{1}{2}, +\frac{1}{2}$ line of Cr^{3+} in $K_3Co(CN)_6$ at 9k Mc/s as a function of temperature, chromium concentration, and the proximity of the $-\frac{3}{2}, -\frac{1}{2}$ line. The experimental procedure, involving inversion of the line, is capable of distinguishing a "bottleneck" relaxation time from a true spin—phonon relaxation time, T_1. At Cr^{3+} concentrations up to 0.5%, the relaxation data are fitted well by single exponential functions of time. Between 1.3° and 4.8° K, T_1 varies approximately as $T^{-1.2}$ indicating that the single phonon process is dominant. No phonon-bath bottleneck is observed, in agreement with calculations based on the measured parameters. A "proximity effect" is observed in which the relaxation rate of the $-\frac{1}{2}, +\frac{1}{2}$ line is enhanced when the $-\frac{3}{2}, -\frac{1}{2}$ line is within 20 linewidths. At 1% Cr^{3+}, the relaxation behaviour is markedly different: the recovery is considerably faster and can no longer be described by a single time constant. This change and the proximity effect are interpreted qualitatively in terms of spin cross-relaxation. The measured linewidth increases with concentration from 0.03% to 2% Cr^{3+}, even though the line is observed to be inhomogeneous at and below 0.5% Cr^{3+}.

539.2 : 538.27

13879 PARAMAGNETIC RESONANCE OF V^{4+} IN TiO_2. H.J.Gerritsen and H.R.Lewis.

Phys. Rev., Vol. 119 No. 3, 1010-12 (Aug. 1, 1960).

The paramagnetic spectrum of vanadium in TiO was observed at 10.14 and 22.68 kMc/s. An analysis of the data indicates that the spectrum is due to single d electrons of tetravalent vanadium ions located at titania sites in the lattice. The calculated values of the components of the g tensor and the hyperfine interaction constant are: $g_x = 1.915$, $g_y = 1.912^5$. $g_z = 1.956^5$, $A_x = 0.0031^5\,cm^{-1}$, $A_y = 0.0043\,cm^{-1}$ and $A_z = 0.0142\,cm^{-1}$. The axes of the magnetic coordinate systems of the two nonequivalent ions per unit cell are: [1,1,0], [0,0,1] [1,1,0] and [1,1,0], [0,0 1], [1,1,0].

539.2 : 538.27

13880 MAGNETIC RESONANCE OF THE ATOMIC LEVELS OF ZINC EXCITED BY ELECTRON BOMBARDMENT.

A.D.May.

C.R.Acad. Sci. (Paris), Vol. 250, No. 22, 3616-17 (May 30, 1960). In French.

A study of the three $^1D_2 - {}^1P_1$ optical transitions of zinc vapour with magnetic resonance excitation at 50 Mc/s and 140 Mc/s and the $4^3P_1 - 4^1S_0$ transition at 50 Mc/s. The lifetime of the excited states and the Landé splitting factors were determined. The latter are very close to the theoretical values for L-S coupling. The origin of the differences is discussed. J.G.Powles

539 2 : 538.27

13881 PARAMAGNETIC-RESONANCE STUDY OF HYPERFINE INTERACTIONS IN SINGLE CRYSTALS CONTAINING α, α-DIPHENYL-β-PICRYLHYDRAZYL.

R.W.Holmberg, R.Livingston and W.T.Smith, Jr.

J. chem. Phys., Vol. 33, No. 2, 541-6 (Aug., 1960).

α, α-Diphenyl-β-picrylhydrazyl (DPPH), with and without N^{15}, contained in single crystals of the corresponding hydrazine, was studied by the paramagnetic-resonance method. All resolved hyperfine effects arise from the two hydrazyl nitrogen atoms. The tensors describing the hyperfine interaction for each nitrogen and the principal-axes directions were deduced. The tensors are interpreted on the basis of an s–p model with the following electron densities: for the α nitrogen $a_s^2 = 0.011$ and $a_p^2 = 0.263$ with the two parts having the same sign of spin density; for the β nitrogen $a_s^2 = 0.024$ and $a_p^2 = 0.396$ or $a_s^2 = 0.010$ and $a_p^2 = 0.605$. The two choices for the β nitrogen arise from an ambiguity in interpreting the hyperfine tensor, but with either choice the two parts have the same sign of spin density.

539.2 : 538.27

13882 A NEW PHOTOTROPIC SUBSTANCE AND ITS E.S.R. T.Hayashi, K.Maeda, S.Shida and K.Nakada.

J. chem. Phys., Vol. 32, No. 5, 1568 (May, 1960).

A light lemon-yellow crystalline substance, considered to be an oxidation product of lophine, is found on irradiation with sunlight or a quartz mercury lamp, to change colour rapidly to a reddish purple. The colour fades on switching off the light, slowly when the substance is in the solid state and rapidly when it is in benzene or dioxan solution. The whole process is reversible. The e.s.r. was detected (and measured) in solution and in the crystalline state.

W.Good

539.2 : 538.27

13883 A GENERAL THEORY OF MAGNETIC DOUBLE RESONANCE. K. Tomita.

Progr. theor. Phys., Vol. 20, No. 5, 743-73 (Nov., 1958).

By using a similar method to that used previously (Abstr. 13887 of 1960), a general theory is presented for describing a system which consists of two interacting different species of spin, one of them being saturated by a strong resonant radiation field and the other being detected by a weak resonant radiation field. Two rather different extreme cases are classified according to the relative magnitude of the static strength of the mutual interaction σ_0 and the characteristic frequency of fluctuation ϕ_0 of the relevant environment. (a) When the fluctuation of the environment dominates ($\phi \gg \sigma_0$), the situation may be called a generalized "Overhauser effect", i.e. the process of saturation works as an energy pumping. Without the effect of the continuous saturation the simultaneous equation reduces to a generalized Solomon equation originally proposed for describing the coupled free induction of two kinds of nuclear spin system. (b) If, on the other hand, the static strength of the mutual interaction dominates the fluctuation ($\sigma_0 \gg \phi_0$), there results a phenomenon called "saturational narrowing", i.e., the process of saturation works as a local field modulation. This latter case has been illustrated by a double resonance experiment on a thallous fluoride crystal.

539.2 : 538.27

13884 ENTROPY AND CROSS-RELAXATION IN SPIN SYSTEMS. A.E.Siegman.

Phys. Rev., Vol. 119, No. 2, 562-3 (July 15, 1960).

Several examples of cross-relaxation and harmonic cross-relaxation between magnetic resonance transitions, both nuclear and electronic, have recently been reported (e.g., Abstr. 8354 of 1959). In these experiments, the appropriate cross-relaxation rate equations have generally been involved to predict the results observed. It is pointed out that if the phenomena can be described in thermodynamic terms using the spin temperatures, then the results can be predicted in a simple fashion by the spin entropy. A simple approximation for the entropy of a multilevel spin system in terms of the population differences Δ_{ij} is derived and applied to a typical cross-relaxation problem.

539.2 : 538.27

13885 CROSS RELAXATION IN RUBY. W.B.Mims and J.D.McGee.

Phys. Rev., Vol. 119, No. 4, 1233-7 (Aug. 15, 1960).

A pulsed microwave method was used to study paramagnetic relaxation in synthetic ruby at Cr/Al concentrations from 0.02 to 0.3%, and over a wide range of fields and angles with respect to the crystal axis. The experimental frequency was 7.17 kMc/s. At settings for which one interval between energy levels was twice as large as another, decay traces with two characteristic periods were observed. The more rapid decay was independent of temperature, and is attributed to a cross-relaxation process involving three spins. Similar behaviour became apparent at all concentrations whenever two intervals approached the same value. At 0.3%, two period deca traces were observed for any arbitrary field and angle setting, indicating at this concentration, a general cross-relaxation betwee the Zeeman levels in times of 0.3 msec and less.

539.2 : 538.2

13886 ON THE OVERHAUSER EFFECT IN SATURATION OF FORBIDDEN RESONANCE. L.L.Buishvili.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1926-7 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York) Vol. 36(9), No. 6, 1369-70 (Dec., 1959).

Expressions are given for the saturation parameter and the parameters which characterize the degree of orientation of the nuclei.

D.J.Olive

539.2 : 538.2

13887 A GENERAL THEORY OF MAGNETIC RESONANCE SATURATION. K.Tomita.

Progr. theor. Phys., Vol. 19, No. 5, 541-80 (May, 1958).

Presents a general theory for describing a spin assembly unde a nearly resonant rotating magnetic field of arbitrary strength. According to the relation between the static local field strength σ_0 and the characteristic frequency ϕ_0 of fluctuation of the environmen two important cases are classified. (a) If the fluctuation of the environment dominates ($\phi_0 \gg \sigma_0$), the equation becomes essentially stochastic in type and one can safely define relaxation times in Bloch's sense with a modification that the restoring force is proportional to the deviation not from the canonical distribution under the constant magnetic field but from the canonical distribution unde the total magnetic field in an instantaneously static system of coordinates (i.e. the modified Bloch equation holds). (b) If, on the other hand, the static local field dominates ($\sigma_0 \gg \phi_0$), then the transverse lifetime depends essentially on the strength of the rotating field, in fact it is prolonged upon saturation. This leads to a genera and reasonable explanation of "saturational narrowing" and the anomalous saturational behaviour of dispersion mode such as have bee observed by Redfield and others in the case of nuclear resonance in metals. The same kind of classification applies to the case in whic two interacting different species of spin occur.

539.2 : 538.27

13888 NUCLEAR SPIN INTERACTIONS IN FERROMAGNETIC AND ANTIFERROMAGNETS. H.Suhl.

J. Phys. Radium, Vol. 20, No. 2-3, 333-5 (Feb.-March, 1959).

In a ferromagnetic or antiferromagnetic crystal the hyperfine coupling between the electrons and the nuclei of the magnetic or no magnetic ions leads to a certain broadening of the nuclear resonanc line. (This phenomenon is already known for samples in the paramagnetic state). Via the hyperfine coupling a particular nucleus excites a virtual spin wave, which is reabsorbed by one of the other nuclei. This sequence of events is equivalent to a long range interaction between the nuclear spins. Since the direction of magnetization furnishes a preferred axis, this coupling is anisotropic with respect to this axis. Thus one obtains a reduction in the transverse relaxation time, T_2. If there are several nuclear species in the sample under examination, the time T_1 may be shortened by the sam mechanism, which enables energy to flow from the species under consideration to the other species.

539.2 : 538.2

13889 NUCLEAR MAGNETIC RESONANCE SPECTRUM OF B^{11} IN INDERITE. K.S.Pennington and H.E.Petch.

J. chem. Phys., Vol. 33, No. 2, 329-34 (Aug., 1960).

The quadrupolar splitting of the B^{11} nuclear magnetic resonanc signal in a single crystal of inderite $Mg_2B_6O_{11}.15H_2O$ at room tempe ture was investigated in a magnetic field of 7187 G. The spectra obtained as the crystal was rotated in turn about three mutually perpendicular axes held normal to the magnetic field were interpreted on the basis that the six B^{11} sites per unit cell belong to three distinct types with the two sites of each type related by a centre of symmetry. The electric quadrupole coupling constants C_Z and asymmetry parameters η at the three unique B^{11} sites were determined to be: $C_Z = eQ\phi_{ZZ}/h$: 355 ± 5, 517 ± 7, 2546 ± 10 kc/s; $\eta = (\phi_{XX} - \phi_{YY})/\phi_{ZZ}$: 0.51 ± 0.03, 0.76 ± 0.01, 0.066 ± 0.003. It is inferred from these values that two of the boron atoms in the asymmetric unit of inderite have tetrahedral coordinations whereas the third has triangular coordination. The orientations of the principal axes of the electric field gradient tensors at the B^{11} sites were also determined.

539.2 : 538.27

13890 NUCLEAR MAGNETIC RESONANCE IN COPPER ALLOYS. ELECTRON DISTRIBUTION AROUND SOLUTE OMS. T.J.Rowland.
s. Rev., Vol. 119, No. 3, 900-12 (Aug. 1, 1960).

The effects of the addition to copper of a wide variety of B group elements on the nuclear magnetic resonance absorption of per are described. The resonance amplitude, which undergoes arp reduction upon alloying, is of special interest; its depend- e upon solute valence and size argues decisively in favour of duction electron charge redistribution (valence effects) as the inant source of the electric field gradients surrounding these tes. Furthermore, these gradients are shown to decrease only ut as $1/r^3$ rather than exponentially as had been supposed. Using proportional change in the lattice parameter of the solid solution a measure of the local strains surrounding a solute atom, only ght correlations between local strains and resonance amplitude e found. It is concluded that the origin of electric gradients und multivalent solutes in copper is almost purely an effect of duction electron distribution and that this distribution is not of exponentially screened Coulomb charge type. The spatially illating charge distribution derived and recognized by Friedel recently elaborated by Kohn and Vosko and Friedel and co- kers satisfactorily explains the observations. See also following tract.

539.2 : 538.27

13891 THEORY OF NUCLEAR RESONANCE INTENSITY IN DILUTE ALLOYS. W.Kohn and S.H.Vosko.
ys. Rev., Vol. 119, No. 3, 912-18 (Aug. 1, 1960).

Experiments of Bloembergen and Rowland (1953) and Rowland e preceding abstract) have shown that the intensity of the nuclear sonance signal in metallic Cu decreases rapidly when small ntities of other elements are alloyed with it. These results quire that each solute atom produces significant electric field dients in its vicinity, sometimes affecting as many as 85 ghbouring Cu nuclei. Here it is shown that field gradients of roximately the required magnitude arise from the redistribution the conduction electron charge density near the solute atoms. A cial feature of this theory is that at large distances r from a ute atom the electron density behaves as $\cos(2k^0 r + \varphi)/r^3$ where is the Fermi wave number and φ is a phase. Agreement with eriment confirms this behaviour. Such an oscillatory behaviour a consequence of a discontinuous drop at the Fermi surface of), the occupation probability of the conduction band function with ve vector $\vec{k}$.

539.2 : 538.27

13892 OBSERVATION OF THE NUCLEAR RESONANCE OF Fe^{57} IN NATURAL METALLIC IRON IN THE ABSENCE AN EXTERNAL FIELD. C.Robert and J.M.Winter.
R. Acad. Sci. (Paris), Vol. 250, No. 23, 3831-3 (June 8, 1960). In ench.

At 295°K the local field is 330 500 Oe. The variation of sonance frequency between 77°K and 310°K agrees with the oretical relation obtained from the theory of spin waves when count is taken of thermal expansion. The frequency measured 77°K agrees with a previous value but that at 295°K does not, bably because a specimen enriched in Fe^{57} was used in the other rk. D.J.Oliver

539.2 : 538.27 : 536.48

NUCLEAR SPIN RELAXATION IN SOLID He^3. See Abstr. 12554

539.2 : 538.27

13893 N.M.R. IN ANTIFERROMAGNETIC $Mn^{19}F_2$. V.Jaccarino and L.R.Walker.
Phys. Radium, Vol. 20, No. 2-3, 341-3 (Feb.-March, 1959).

Precise measurements have been made of the n.m.r. frequency F^{19} nuclei in antiferromagnetic MnF_2. The interaction energy F^{19} is assumed proportional to the mean local spin polarization of paramagnetic electrons averaged over a nuclear period. This, in n, is taken to measure the sublattice magnetization. At low mperatures (below $T_{AE} = 13^0$K, where kT_{AE} is the energy of an tiferromagnetic resonance quantum) it appears that $\frac{d \log \Delta\nu}{d \log T}$ creases steadily as T decreases, where $\Delta\nu = \nu_F(T) - \nu_F(0)$. This evidence for an energy gap in the spin wave spectrum, having its igin in the anisotropy. Detailed numerical agreement with the gnetization curve predicted by Eisele and Keffer from spin wave theory is not obtained. At higher temperatures (13.8°K-21.2°K and 40°K-55°K) the magnetization is substantially above that given by molecular field theory.

539.2 : 538.27

13894 NUCLEAR RESONANCE AND DIELECTRIC RELAXATION IN CRYSTALS OF SOME LONG-CHAIN SECONDARY ALCOHOLS. J.G.Powles and J.A.E.Kail.
Trans Faraday Soc., Vol. 55, Pt 12, 1996-9 (Dec., 1959).

Proton magnetic resonance absorption measurements are reported for 8-eicosanol solidified from the melt and for 14-heptacosanol, one sample being solidifed from the melt and another recrystallized from solution. The proton resonance measurements are similar for both samples of 14-heptacosanol whereas their dielectric properties differ markedly. The measurements indicate that the dielectric relaxation process involves less than 3% of the protons and therefore supports current theories of the dielectric relaxation process in these materials. The inter-chain hydrogen bonding does not appear to affect significantly the motion of the carbon chains compared with the chain mobility in paraffin crystals of comparable chain length.

539.2 : 538.27

13895 THE NUCLEAR SPIN RESONANCE SPECTRUM OF Na^{23} IN SINGLE CRYSTALS OF SODIUM NITRITE, $NaNO_2$. A.Weiss.
Z. Naturforsch. Vol. 15a, No. 5-6, 536-42 (May-June, 1960). In German.

A study of the quadrupole splitting of the Na^{23} resonance in a single crystal of sodium nitrite at room temperature. The splitting constant is 1.1003 Mc/s and the assymetry parameter 0.1092. The relation of the field gradient tensor to the crystal axis is determined. J.G.Powles

MECHANICAL PROPERTIES OF SOLIDS

539.3

13896 AN ULTRASONIC PULSE METHOD OF MEASURING THE ELASTIC MODULI OF MONOCLINIC CRYSTALS. K.S.Aleksandrov.
Kristallografiya, Vol. 3, No. 5, 623-6 (Sept.-Oct., 1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 5, 630-2 (Dec., 1959).

An ultrasonic pulse method is described and results for potassium tartrate are reported. Previously, resonance methods had to be used for monoclinic crystals. C.A.Hogarth

539.3

13897 ELASTIC CONSTANTS OF SINGLE-CRYSTAL ALUMINUM ANTIMONIDE. D.I.Bolef and M.Menes.
J. appl. Phys., Vol. 31, No. 8, 1426-7 (Aug., 1960).

The ultrasonic c.w.resonance technique was used to measure the adiabatic elastic constants of single crystal aluminium antimonide at 27°C. The values for the elastic stiffness constants, in units of 10^{11}d/cm^2, are: $c_{11} = 8.939$, $c_{12} = 4.427$, and $c_{44} = 4.155$. A theoretical density of 4.36 g/cm^3 was used. The values of c_{11} and c_{44} for single crystal GaSb obtained by the c.w. resonance technique are compared with previous values obtained by pulse-echo techniques.

539.3

13898 ELASTIC CONSTANTS OF CADMIUM FROM 4.2°K TO 300°K. C.W.Garland and J.Silverman.
Phys. Rev., Vol. 119, No. 4, 1218-25 (Aug. 15, 1960).

The adiabatic elastic constants of cadmium single crystals were measured by an ultrasonic pulse technique. The values extrapolated to 0°K are: $c_{11} = 13.08$, $c_{33} = 5.737$, $c_{44} = 2.449$, $c_{12} = 4.048$, $c_{13} = 4.145$ in units of 10^{11} dynes/cm^2. A Debye characteristic temperature, θ_0, of 213° ± 1°K was calculated from these 0°K elastic constants. The temperature dependence of the linear compressibilities, K and K , was also calculated.

539.3

13899 ELASTIC CONSTANTS OF SYNTHETIC SINGLE CRYSTAL CORUNDUM AT ROOM TEMPERATURE. J.B.Wachtman, Jr, W.E.Tefft, D.G.Lam, Jr, and R.P.Stinchfield.
J. Res. Nat. Bur. Stand., Vol. 64A, No. 3, 213-28 (May-June, 1960).

The six elastic constants (and six elastic compliances) of corundum were determined in the kilocycle per second frequency range by an accurate resonance method. The results were checked in the megacycle per second range with a less accurate, pulse velocity method. The elastic moduli for polycrystalline alumina calculated from the single crystal compliances determined by the resonance method are in good agreement with experimental values obtained on high density polycrystalline alumina. The variation of Young's modulus and of the shear modulus with orientation was calculated from the compliances and the results are shown graphically. The results of the present work do not agree well with previous work on single crystal sapphire. The specification of orientation and the theory used to calculate the elastic constants are given in detail to support the contention that the results of the present work are correct.

539.3

13900 TEMPERATURE DEPENDENCE OF YOUNG'S MODULUS OF VITREOUS GERMANIA AND SILICA.

S.Spinner and G.W.Cleek.
J. appl. Phys., Vol. 31, No. 8, 1407-10 (Aug., 1960).

The temperature dependence of Young's modulus of vitreous GeO_2 has been determined by a dynamic resonance method from −195°C to 540°C. The modulus increases with increasing temperature from about −120°C to 400°C. Below and above this range the modulus decreases with increasing temperature. Young's modulus for vitreous SiO_2 also increases from about −190°C to 1175°C and decreases with increasing temperature outside this range. In view of the similarity in structures and bond energies of these two materials, the similarity in the elastic modulus-temperature relations is believed to be significant; especially when contrased with the lack of agreement in another commonly measured anharmonic property, thermal expansion.

539.3

13901 ELASTICITY OF SOME HIGH-DENSITY CRYSTALS.

R.K.Verma.
J. geophys. Res., Vol. 65, No. 2, 757-66 (Feb., 1960).

The adiabatic elastic constants of two garnets (spessartite-almandite and almandite), spinel (synthetic), rutile (synthetic), and olivine are reported. The stiffness constants C_{pq} were determined from the velocities of acoustic wave propagation in crystals. The velocities of wave propagation were measured by McSkimin's (Abstr. 7989 of 1953) method. A frequency range of 6 to 12 Mc/s was used.

539.3

13902 ULTRASONIC MEASUREMENT OF THE ELASTIC MODULI OF RUTILE.

G.L.Vick and L.E.Hollander.
J. Acoust. Soc. Amer., Vol. 32, No. 8, 947-9 (Aug., 1960).

Four of the elastic moduli of rutile have been determined by measuring the velocity of 10 Mc/s ultrasonic waves. They are $C_{11} = 2.48 \pm 0.08$, $C_{33} = 4.52 \pm 0.08$, $C_{44} = 1.20 \pm 0.03$, and $C_{66} = 1.6 \pm 0.1$, all $\times 10^{12}$ d/cm². The remaining two, $C_{12} = 2.0 \pm 0.1 \times 10^{12}$ d/cm² and $C_{13} = 1.4 \pm 0.1 \times 10^{12}$ d/cm², were computed from the given data and Bridgman's compressibility data. These values are, within the exception of C_{33}, in good agreement with values computed from force constant data. No change in elastic moduli was noted upon reduction to a resistivity of 0.2 ohm/cm. It was noted that attenuation was greater in reduced than in fully oxidized rutile and was considerably greater in the a than in the c crystallographic direction.

539.3

13903 HOOKE'S LAW IN SHEAR AND POLYMER MELT FRACTURE.

E.B.Bagley.
J. appl. Phys., Vol. 31, No. 6, 1126-7 (June, 1960).

Philippoff and Gaskins have recently derived a relationship between recoverable shear strain and the total and viscous capillary end corrections (Transactions of the Society of Rheology, Vol. II, p.263). It is now shown that when this relationship is combined with the assumption that the shear obeys Hooke's law a linear relationship is obtained between the capillary end corrections and the shear stress. From the slope of such a plot a molecular weight can be derived for linear polymer molecules which agrees with the value obtained from intrinsic viscosity measurements. The analysis is only valid at shear stresses lower than the critical shear stress at which extruded polymer filaments become distorted. The experimental results can be interpreted to show that melt fracture occurs after the recoverable shear strain reaches a definite critical value.

A.E.Kay

539.

13904 PRESSURE VARIATION OF THE ELASTIC CONSTANTS OF SODIUM.

W.B.Daniels.
Phys. Rev., Vol. 119, No. 4, 1246-52 (Aug. 15, 1960).

The pressure variation of the single-crystal elastic constants was measured using a modified ultrasonic pulse echo method. The values found for the pressure derivatives of the elastic constants ar $dC_{44}/dP = 1.63$, $dC'/dP = 0.226$, $dB_S/dP = 3.60$. The notation $C' = (C_{11} - C_{12})/2$ and $B_S = (C_{11} + 2C_{12})/3$ has been used. The experimental observation that the elastic anisotropy ratio $C/C' (C \equiv C_{44})$ does not depend on pressure indicates that one can positively neglec interaction of ion cores as a contribution to the elastic stiffness of sodium. The results are interpreted in terms of Fuchs' theoretical calculation (1936) of the Coulomb contribution to the shear stiffness of the alkali metals. The interpretation indicates that as sodium is compressed, the value of the electronic wave-function at the boundaries of the atomic polyhedra increases more rapidly than $\Omega^{-1/2}$, where Ω is the volume of the atomic polyhedron. The volume variation of the value of the wave-function of the lowest electronic state at the boundaries of the atomic polyhedra is found to be:

$$\left[\frac{d \ln \mu_0(r_S)}{d \ln \Omega}\right]_{\Omega = \Omega_0} = -0.27.$$

539.

13905 A COMPARISON OF EXPERIMENTAL AND THEORETICAL RELATIONS BETWEEN YOUNG'S MODULUS AND THE FLEXURAL AND LONGITUDINAL RESONANCE FREQUENCIES OF UNIFORM BARS.

S.Spinner, T.W.Reichard and W.E.Tefft.
J. Res. Nat. Bur. Stand., Vol. 64A, No. 2, 147-55 (March-April, 196

The relations from which Young's modulus may be computed from mechanical flexural and longitudinal resonance frequencies have been established by an empirical method using two sets of stee bars. Both sets contained rectangular and cylindrical specimens. For longitudinal vibration of cylindrical specimens, the agreement between the empirical curves and Bancroft's corresponding theoretical relation was within experimental error if Poisson's ratio for both sets is taken to be 0.292. For flexural vibrations, the agreement between the empirical curve and the corresponding theoretical relation developed by Pickett is also within experimental error for about the same value of Poisson's ratio for the rectangular specimens of both sets; but for cylindrical specimens, the empirical values are somewhat lower than those predicted by the theory.

539.3 : 539.17

THERMAL STRESSES IN REACTOR FUEL ELEMENTS.
See Abstr. 13369

539.

13906 THERMODYNAMIC INEQUALITIES FOR ELASTIC SOLIDS.

J.C.M.Li and H.S.Kiang.
J. chem. Phys., Vol. 32, No. 6, 1644-6 (June, 1960).

A table of all the positive quantities among measurable coefficients is given for anisotropic elastic solids under the variation of only temperature and stress. Examples of inequality formulatio are presented. Upper or lower limits containing only the Grüneisen parameter and heat capacities are derived for adiabatic and isothermal compressibilities, thermal expansion, and thermal stress.

539.

13907 SURFACE ELASTIC WAVES IN CUBIC CRYSTALS.

D.C.Gazis, R.Herman and R.F.Wallis.
Phys. Rev., Vol. 119, No. 2, 533-44 (July 15, 1960).

A theoretical investigation of surface elastic waves in cubic crystals has been carried out using a theory developed by Stoneley (Abstr. 2730 of 1956). The range of elastic constants for which Rayleigh type surface waves exist on a (100) free surface has been determined. For other allowed values of the elastic constants generalized Rayleigh waves exist which are characterized by complex attenuation constants. In either case waves may not be propagated in certain directions parallel to the surface depending on the values of the elastic constants. A lattice dynamical theory of surface wav has been developed for a monatomic simple cubic lattice with neare and next nearest neighbour central forces and angle-bending forces involving successive nearest neighbours. The surface waves exhib dispersion when the wavelength is comparable to the lattice spacing In the case of Rayleigh waves a critical wavelength exists, in gener such that for shorter wavelengths the atomic displacements show a reversal in phase between successive layers parallel to the surface

539.3

13908 THE EFFECT OF ULTRAVIOLET AND X-RAY IRRADIATION ON THE INTERNAL FRICTION OF LVER CHLORIDE.

M.P.Shaskol'skaya and Yu.Kh.Vekilov.
z. tverdogo Tela, Vol. 2, No. 6, 1107-10 (June, 1960). In Russian.

The internal friction, Q^{-1}, of both plastically deformed and nealed AgCl decreased, when this substance was subjected to ultraolet and/or X-ray irradiation. In the former case Q^{-1} decreased ponentially with the exposure time. Both types of irradiation creased the tensile strength of AgCl. It was inferred that internal ction is caused by movement of dislocations. M.H.Sloboda

539.3

13909 TWINS AND FORMATION OF SUB-BOUNDARIES DURING DEFORMATION OF ZINC.

L.I.Vasil'ev.
z. Metallov i Metallovedenie, Vol. 9, No. 1, 158-60 (1960). Russian.

Microscopic examination of plastically deformed zinc revealed at twinning may promote fragmentation of the crystals in the gions adjacent to the ends of elongated twins. This effect was tributed to the existence of over-stressed regions at the ends of twinned crystals. M.H.Sloboda

539.3

13910 TEMPERATURE DEVELOPMENT BASED ON TECHNOLOGICAL ANALYSIS: FAST ROLLING AS AN EXAMPLE.

Lippmann and W.Johnson.
ppl. sci. Res. A, Vol. 9, No. 5, 345-56 (1960).

The mean rise in temperature with plastic strain due to the ork of plastic deformation, taking account of the temperaturependence of yield strees, is investigated when conduction effects e neglected and results for one particular example are presented. adaptation of the Siebel—Karman analysis for sheet rolling is amined, and results for the particular case of rolling a medium rbon steel are given in detail. The temperature-dependent propty of the yield stress in cold-rolling at moderate reductions is own not to have a large effect on factors such as roll-torque, ough the actual temperature increase generated is a significant e. Examples are given of how the temperature of the material creases in its passage through the roll gap.

539.3

13911 NON-STEADY MEMBRANE CREEP OF CIRCULAR PLATES.

F.K.G.Odqvist.
k. Fys., Vol. 16, Paper 43, 527-31 (1960).

This is an extension of earlier work on the plastic deformation a plane circular membrane, assuming a non-linear relationship tween stress and strain rate tensors and finite deformation, to clude the case of incipient creep of a metallic membrane. H.J.H.Starks

539.3

13912 INVESTIGATION OF THE DISPLACEMENT OF THE GRAIN BOUNDARIES IN CREEP.

M.Rozenberg and I.A.Epshtein.
iz. Metallov i Metallovedenie, Vol. 9, No. 1, 124-32 (1960). In ussian.

It was inferred from observations, made on Al specimens 9.99% purity) during various stages of creep, that displacement the grain boundaries during creep constitutes a form of recrystalzation which takes place by absorption of some grains by their ighbours, no formation and growth of recrystallization nuclei being volved. The process, which is not directly dependent on the lative orientation of the adjacent grains, does not result in the formation of the specimen on the macroscopic scale, but is companied by an increase in the ductility of the metal. The actition energy for the grain boundary displacement in Al during eep at 275-325°C under a stress of approximately 0.4 kg/mm^2 as 18 000 cal/mol. M.H.Sloboda

539.3

13913 PLASTIC CREEP OF GERMANIUM SINGLE CRYSTALS IN BENDING.

P.Penning and G.de Wind.
ysica, Vol. 25, No. 9, 765-74 (Sept., 1959).

The vertical displacement of the centre of a bar supported on o knife-edges and loaded in the centre, caused by plastic flow, as measured as a function of time. First the creep rate increases adually and then becomes constant. The parameters describing e behaviour in these two regions have been determined as a funcon of the applied stress, for crystals of low and high dislocation nsities and crystals doped with oxygen.

539.3

13914 THEORY OF CREEP OF GERMANIUM CRYSTALS.

H.G.van Bueren.
Physica, Vol. 25, No. 9, 775-91 (Sept., 1959).

To explain the shape of the creep curves of germanium single crystals loaded in tension and in bending, a simple kinetic model is proposed, in which the dislocations are generated by (surface) sources and move with a uniform velocity over their glide planes. In this model a quantitative interpretation of the parameters of the creep curve in terms of the velocity of the dislocations, the incubation time of the sources and the density of the sources is possible. From the observations at "high" stress levels the velocity of dislocations in the germanium lattice can be determined; from those at "low" stress levels the rate of generation of the dislocations from the sources. The observed stress and temperature dependence of the creep process leads to similar dependences of incubation time and velocity. These dependences are used to form a quantitative theory of dislocation production and motion in the germanium lattice. This theory is shown to reflect semi-quantitatively various observed pecularities of the creep phenomenon. The influence of other dislocations and of oxygen as an impurity on the elementary creep process can now also be qualitatively understood.

539.4

13915 STUDY OF THE MECHANICAL PROPERTIES OF SOLIDS, PARTICULARLY METALS, AT TEMPERATURES BELOW 4.2°K. I. TENSILE TESTS ON POLYCRYSTALLINE ALUMINIUM (99.3% PURITY).

O.V.Klyavin and A.V.Stepanov.
Fiz. Metallov i. Metallovedenie, Vol. 8, No. 2, 274-81 (1959). In Russian.

Tensile tests were carried out at 300, 78, 4.2, and 1.6°K on polycrystalline aluminium in the work-hardened and annealed condition. Both elongation and tensile strength increased with falling temperature and at 1.6°K the true tensile strength of aluminium approached its theoretical value (~160 kg/mm^2). The nature of fracture of aluminium changed in the 4.2-1.6°K range, and the stress/strain curve obtained at 1.6°K was characterized by a large number of "kinks" in the plastic deformation region. M.H.Sloboda

539.4

13916 SKELETON STRENGTH AND CRITICAL POROSITY IN SET SULPHATE PLASTERS.

K.K.Schiller.
Brit. J. appl. Phys., Vol. 11, No. 8, 338-42 (Aug., 1960).

A theory dealing with the strength of porous brittle bodies which has been shown previously to apply to neat plasters is extended to cover sand bearing plasters. The sand grains have to be regarded as solid pores. The strength of sanded plasters is equal to that of the plaster matrix cementing the sand grains together. In spite of the increase of the characteristic parameters with sand content plasters are in practice the weaker the more sand they bear. This is because more water has to be added with respect to the plaster to obtain the desired consistency. The results are derived graphically from a special representation of the experimental results. Griffith's crack theory of brittle strength is shown to apply to the quality factor.

539.4

13917 RESISTANCE TO ABRASION AND THE ELASTIC MODULI OF METALS AND ALLOYS.

M.M.Khrushchov and M.A.Babichev.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 6, 1319-22 (April 21, 1960). In Russian.

Experiments, carried out on Sn, Cd, Al, Zn, Au, Ag, Cu, Pd, Zr, Pt, Ni, Fe, Co, Cr, Rh, Mo, Be, and W, showed that the wear resistance of metals, ϵ, is related to their elastic properties according to $\epsilon = 0.49 \times 10^{-4} E^{1.3}$, where E is the normal elasticity modulus, and ϵ is expressed in arbitrary units, related to ϵ of a standard Pb—Sn alloy. The formula was found to be applicable to Cu—Ni and Pb—Sn alloys, and to describe adequately the relationship between ϵ and E for babbits, brasses, and super-hard alloys. M.H.Sloboda

539.5

13918 THE RHEOLOGICAL BEHAVIOUR OF HYDROGEN-BONDED SOLIDS. III. A THEORY OF TENSILE STRENGTH.

A.H.Nissan.
Trans Faraday Soc., Vol. 55, Pt 12, 2048-53 (Dec., 1959).

For Pt I and II, see Trans Faraday Soc., Vol. 53, Pt 5, 700-9, 710-21 (May, 1957). A chain of m bonds of mean energy $\bar{\epsilon}$, with standard deviation σ, will fail under tension when it has absorbed an energy equal to $m\bar{\epsilon}[1 - t(\sigma/\bar{\epsilon})]$ where $t\sigma$ is the largest multiple of σ which has a relative probability of at least 1/m. By assuming that the frequency of different energy values for the hydrogen-bond follows a normal error law, it is shown that a criterion for the efficiency η of utilizing the available bonds defined as 100 times the ratio of the rupture energy (R.E.) to $n\bar{\epsilon}$, where n = number of bonds per cm^3, is given by

$$\eta = 100\{1 - [\sqrt{2\ln(Sn^{1/3}/\sqrt{2\pi})}]\ (\sigma/\bar{\epsilon})\}\ ,$$

where S = length of test piece in cm. Using previously found values for n and $\bar{\epsilon}$ for cellulose, this equation becomes

$$\eta = 100\{1 - \sqrt{[2\ln(SE/7 \times 10^3\sqrt{2\pi})]}(\sigma/\bar{\epsilon})\}\ ,$$

where E is Young's modulus and where $(\sigma/\bar{\epsilon})$ is estimated at between 0.14 and 0.24. Checking this equation against recently found values for R.E. and E for a large number of papers shows the equation to be valid (with $13.2 < 100(\sigma/\bar{\epsilon}) < 14.5$), when hydrogen bonds dominate the structure, i.e., when $2.0 \times 10^{10} < E < 10.0 \times 10^{10}$. Below $E = 2.0 \times 10^{10}$, van der Waals forces become of increasing significance in cellulose; their contribution to R.E. is estimated.

539.5

13919 THE RELATION OF MICROHARDNESS TO LOAD FOR NaCl MONOCRYSTALS.

Yu.S.Boyarskaya, Yu.P.Keloglu, M.K.Bologa and V.V.Mednets.
Kristallografiya, Vol. 4, No. 4, 597-602 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 4, 558-63 (April, 1960).

The microhardness of a natural NaCl monocrystal depends on the load. The elastic recovery of an indent is estimated theoretically and experimentally, and is shown to be so small that it can have no important effect on the relation of microhardness to load. The surface near the indent has been examined to show that the ridges at the edges of the indent affect the microhardness substantially.

539.5 : 539.2 : 548

DEPENDENCE OF THE FORM OF AN INDENTATION ON THE SYMMETRY OF THE CRYSTAL FACES IN THE DETERMINATION OF HARDNESS BY THE PENETRATION OF A DIAMOND PYRAMID. See Abstr. 13931

539.5

13920 ON THE INFLUENCE OF THE ANISOTROPY OF THE BASE ON THE RESISTANCE OF A ROLLING CYLINDER.

J.Halaunbrenner.
Acta phys. Polon., Vol. 17, No. 2-3, 83-92 (1958).

The directional dependence of the resistance of a cylinder rolling on anisotropic surfaces is determined experimentally for the case of artificial anisotropy produced by machine working and of natural anisotropy of wood and NaCl monocrystals.

CRYSTALLOGRAPHY
CRYSTAL STRUCTURES

539.2 : 548

13921 CRYSTAL PHYSICAL PROPERTIES OF $Ag_2SO_4.4NH_3$.

S.Haussühl.
Z. Naturforsch., Vol. 15a, No. 5-6, 549-50 (May-June, 1960). In German.

Crystals of great strength were obtained from solution with a slight ammonia excess. The crystals of class $P\bar{4}2_1c$ had highly anisotropic physical properties. C.A.Hogarth

539.2 : 548

13922 THE INHERENT SYMMETRY OF ATOMS AND MOLECULES IN A CRYSTAL.

A.V.Shubnikov.
Kristallografiya, Vol. 3, No. 4, 521-4 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 527-9 (July-Aug., 1958).

A discussion on the distinction between the symmetry which bodies have in the free state (inherent symmetry) and the symmetry they have due to some constraint imposed on them by their environment (imposed symmetry). In a crystal the molecular symmetry observed is the "imposed symmetry". In cases, such as NH_4Cl, where the morphological crystal symmetry is not in accord with that found by X-ray diffraction it is suggested that the inherent symmetry of the atoms is not displayed in the crystal. J.Iball

539.2 : 548

13923 THE IMPOSSIBILITY OF DISTRIBUTING CENTRO-SYMMETRIC MOLECULES IN NONCENTROSYMMETRI GROUPS.

A.I.Kitaigorodskii.
Kristallografiya, Vol. 3, No. 3, 391-2 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 393-4 (May - June, 1958).

The author claims that it is against "common-sense" for molecules which possess a centre of symmetry to crystallize in a space group which does not have a centre of symmetry. It would also contradict the theory of close packing. Examples of such "centrosymmetrical" molecules which crystallize in non-centrosymmetrical space groups are (1) mercury-ethyl mercaptan, (2) difluoroenylidene, (3) 4,4' dinitrodiphenyl, (4) 1 : 2 : 5 : 6-dibenzanthracene (β-form). It is claimed that further detailed analysis will show that these molecule are not in fact centrosymmetrical. In the case of (4) the author suggests that there are two isomers, the α-form being trans- and the β-form being cis-. In neither case will the molecule be planar. J.Iball

539.2 : 548

13924 SYMMETRY AND ANTISYMMETRY OF RODS AND SEMICONTINUA WITH A PRINCIPAL AXIS OF INFINITE ORDER AND FINITE TRANSLATIONS ALONG IT.

A.V.Shubnikov.
Kristallografiya, Vol. 4, No. 3, 279-85 (May-June, 1959). In Russia English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 3, 261-6 (March, 1960).

A derivation and description are given of groups of symmetry (including antisymmetry). It is shown that there are 25 such groups Of them, seven are colourless (grey), seven are one-coloured, and eleven are two-coloured (black—white) The groups of correspondin layered semicontinua are obtained by combining the rod groups with groups of all possible translations along directions perpendicular to the principal axis of the rods.

539.2 : 548 : 538.2

FERROMAGNETIC PHASE TRANSITIONS AND THE SYMMETR OF CRYSTALS. See Abstr. 13760

539.2 : 548

13925 THE USE OF STRUCTURE DELINEATION FUNCTIONS OF INTERATOMIC VECTORS FOR FINDING THE PHASES OF STRUCTURE AMPLITUDES.

V.I.Simonov and B.K.Vainshtein.
Kristallografiya, Vol. 4, No. 4, 505-9 (July-Aug., 1959). In Russian English translation in: Soviet Physics—Crystallography (New York), 476-80 (April, 1960).

The superposition method is used to derive formulae for the phases of structure amplitudes. One formula is tested on the h0l reflections for sidoserite, whose structure is known.

539.2 : 548

13926 THE NOMENCLATURE OF THE 80 PLANE GROUPS IN THREE DIMENSIONS.

N.V.Belov.
Kristallografiya, Vol. 4, No. 5, 775-8 (Sept. - Oct., 1959). In Russian English translation in: Soviet Physics—Crystallography (New York) Vol. 4, No. 5, 730-3 (May, 1960).

The author refutes the claim by Dornberger-Schiff [Acta cryst. Vol. 12, 173 (1959)] that she was the first to list the 80 plane groups in the two-sided plane. In the present paper, a table is given of the 46 "two-colour" groups and of the 34 degenerate groups (17 "one-colour" and 17 "grey" groups). The International symbols are given together with Schoenflies symbols. The significance of the 80 groups in the use of generalized projections and in problems of twinning is emphasized. J.Iball

539.2 : 54

13927 EDGE FORMS OF THE CUBIC SYSTEM.

S.Sh. Gendelev and I.I.Shafranovskii.
Kristallografiya, Vol. 3, No. 4, 405-15 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 407-16 (July-Aug., 1958).

The results of a derivation of edge forms for the cubic system are given. Tables are presented which depict all the edge forms of symmatry class O_h, as well as tables with the symbols of the face forms on which they are present. The number of edge forms for all five classes of symmetry in the cubic system are indicated.

539.2 : 548

13928 GEOMETRICAL VARIETIES OF FACE FORMS FOR CRYSTALS FALLING IN THE CLASSES OF LOW MMETRY. I.I.Shafranovskii.
istallografiya, Vol. 4, No. 3, 293-301 (May-June, 1959). In ssian. English translation in: Soviet Physics—Crystallography ew York), Vol. 4, No. 3, 274-80 (March 1, 1960).

The varieties of face forms are deduced with allowance for sitive and negative forms and for polyhedra with re-entrant gles.

539.2 : 548

13929 GEOMETRICAL VARIETIES OF FACE FORMS FOR CUBIC CRYSTALS. I.I.Shafranovskii.
istallografiya, Vol. 4, No. 4, 477-86 (July-Aug., 1959). In Russian. glish translation in: Soviet Physics—Crystallography (New York), l. 4, No. 4, 452-9 (April, 1960).

The geometrical varieties of face forms for cubic crystals are duced with allowance for positive and negative forms, for face ts, and for polyhedra with re-entrant angles. Numerous examples e given of real crystals showing these forms, mainly for skeletal rms and twinned intergrowths.

539.2 : 548

13930 MICROSCOPIC OBSERVATIONS OF THE SURFACE OF InSb MONOCRYSTALS. J.Auleytner and B.Kołakowski.
cta phys. Polon., Vol. 17, No. 2-3, 93-6 (1958).

Etched and cleaved surfaces with crystallographic indices (100), 11) and (110) were investigated. It was shown that the shape of the ch pits is different for the various crystallographic surfaces. Two pes of etched figure were observed; they differ in size and in nsity. Suitable etching agents were chosen to reveal the figures.

539.2 : 548 : 539.5

13931 DEPENDENCE OF THE FORM OF AN INDENTATION ON THE SYMMETRY OF THE CRYSTAL FACES IN HE DETERMINATION OF HARDNESS BY THE PENETRATION F A DIAMOND PYRAMID. V.A.Mokievskii.
ristallografiya, Vol. 4, No. 3, 410-13 (May-June, 1959). In Russian. nglish translation in: Soviet Physics—Crystallography (New York), l. 4, No. 3, 381-4 (March, 1960).

On the basis of the symmetry of the diamond pyramid and of e crystal faces, all the possible classes of symmetry of indentaons are derived, and many of them are confirmed experimentally. he suggestion is made that it may be useful to take into account e symmetry of the indentations when determining the orientation the grains in a polished specimen. Certain additions are prosed to the design of the PMT-3 instrument, which are desirable hen the hardness is to be determined on different faces of a ystal.

539.2 : 548 : 537.311

13932 PECULIARITIES OF THE CRYSTAL CHEMISTRY OF TRANSITION METAL SEMICONDUCTING COMPOUNDS. .D.Dudkin.
iz tverdogo Tela, Vol. 2, No. 3, 397-403 (March, 1960). In Russian.

A more detailed presentation of the author's previous arguents (Abstr. 1625 of 1960). The concept of a critical metal—etal distance (defined in terms of the normal radius of the metal om for the appropriate coordination) appears to provide a ready eans of distinguishing between metals and semiconductors ystallizing in a large number of structures, including NiAs, aCl, $CuAl_2$ and FeS_2 lattices, and various disilicides. (See also bstr. 7832, 11554 of 1960). C.H.L.Goodman

539.2 : 548.5

13933 DETERMINING GRAIN ORIENTATION IN F.C.C. METALS BY USING TWIN-BOUNDARY OR SLIP-LINE RACES ON ONE SURFACE ONLY. H.Mykura.
ull. Inst. Metals, Vol. 4, Pt 14, 102-4 (Oct., 1958).

Barrett's method of determining crystal orientation, using aces of known planes on one surface, is discussed. In the case of 11) plane traces in cubic crystals a rule is given stating the number possible solutions for any arbitrary number of traces and angles etween traces. H.Mykura

539.2 : 548.5

13934 MUTUAL ORIENTATION OF SINGLE CRYSTAL GOLD LAMELLAE. M.Gillet.
.R. Acad. Sci. (Paris), Vol. 250, No. 23, 3810-12 (June 8, 1960). French.

Thin films of gold were prepared by evaporation onto silver films 200 A thick grown epitaxially on heated molybdenite. The gold films were removed by nitric acid and studied by electron diffraction. The diffraction patterns may be interpreted as being due to two identical, superimposed layers that have been rotated with respect to each other. The mechanism of this rotational slip is briefly discussed. T.Mulvey

539.2 : 548.5

13935 THE SOLUBILITIES OF THE VARIOUS FACES OF A CRYSTAL. A.V.Belyustin.
Kristallografiya, Vol. 4, No. 4, 609-12 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 4, 569-71 (April, 1960).

Thermodynamic arguments are used to show that the fact that the faces relate to different simple forms, of itself cannot cause any solubility differences. The roles of the sizes of the faces and of conditions at the edges are considered.

539.2 : 548.5

13936 THE ELASTIC STAGES OF TWINNING IN METAL MONOCRYSTALS. V.M.Kosevich and V.I.Bashmakov.
Kristallografiya, Vol. 4, No. 5, 749-55 (Sept.-Oct., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 709-13 (May, 1960).

The widths of the twinned layers in monocrystals of bismuth, antimony and zinc were measured as functions of load. It is considered that the elastic behaviour of these layers is restricted by plastic deformation, which occurs via slip.

539.2 : 548.5

13937 STUDY OF TWINNING IN CALCITE CRYSTALS BY MEANS OF AN X-RAY MICRO-BEAM AND ETCH FIGURES. E.V.Kolontsova, Yu.G.Sorokina and I.V.Telegina.
Kristallografiya, Vol. 4, No. 5, 742-8 (Sept.-Oct., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 702-9 (May, 1960).

X-ray photographs have been taken by the Laue method using a narrow beam (of the order of 15 μ) of different parts of a crystal deformed by twinning. The arrangement of etch figures on the crystal was compared with the X-ray data.

539.2 : 548.5

13938 ABSENCE OF IRRADIATION GROWTH IN ALPHA-URANIUM ABOVE 430°C. M.Balicki.
Nuclear Sci. Engng, Vol. 4, No. 3, 502-4 (Sept., 1958).

539.2 : 548.5

13939 INVESTIGATION OF ACTIVATOR DISTRIBUTION IN ALKALI HALIDE CRYSTALS BY THE RADIOACTIVE-TRACER METHOD. II.
L.M.Belyaev, V.A.Perl'shtein and V.P.Panova.
Kristallografiya, Vol. 3, No. 4, 506-7 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 510-11 (July-Aug., 1958).

For Pt I see Abstr. 3559 of 1958. The distribution of Tl^{204} in crystals of KI grown by the Stockbarger method is measured with TlCl, TlBr, and TlI as activators. The capture coefficients for Tl are in the order $I > Br > Cl$. There is no effect on the emission spectra or scintillation intensities of the crystals. The distribution of the activator anion is measured using $TlBr^{82}$ and TlI^{131}, and conforms to the same laws as the cation. R.F.S.Hearmon

539.2 : 548.5

13940 TEMPERATURE CONDITIONS ON THE SURFACE OF A GROWING MARTENSITE CRYSTAL.
B.Ya.Lyubov and A.L.Roitburg.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 4, 809-12 (April 1, 1960). In Russian.

The thermal conditions are analysed in terms of the heat of transition and the thermal conductivity, assuming the crystal to have an elongated elliptical form. It is concluded that the conditions are isothermal at first, but become adiabatic later.
R.F.S.Hearmon

539.2 : 548.5

13941 DAMAGED LAYERS AND CRYSTALLINE PERFECTION IN THE (111) SURFACES OF III-V INTERMETALLIC COMPOUNDS. E.P.Warekois, M.C.Lavine and H.C.Gatos.
J. appl. Phys., Vol. 31, No. 7, 1302-3 (July, 1960).

Sand-blasting or grinding causes a greater depth of damage in the GaAs and InSb (111) surfaces which terminate with group 5 atoms than in the (111) surfaces which terminate with group 3 atoms. In undamaged crystals the former surfaces are the more perfect.
C.Hilsum

539.2 : 548.5

13942 THE COEFFICIENT OF DISTRIBUTION OF TIN IN SELENIUM.

D.M.Chizhikov and V.M.Édel'shtein.

Fiz. tverdogo Tela, Vol. 2, No. 5, 863-5 (May, 1960). In Russian.

The distribution of impurities after zone refining is given by

$$c/c_0 = 1 - (1 - K) \exp -kx/a,$$

where c is the impurity concentration in the solid phase after zone refining, c_0 the initial impurity content in the whole ingot, a the width of the molten zone, and K the effective coefficient of distribution of impurities. Using the radioactive tracer (Sn^{113}) technique, it was found that for Sn in Se, $K = 0.90 \pm 0.05$, and that the effective coefficient of diffusion of Sn in Se, $D = 1.9 \times 10^{-3}$ cm^2/sec.

M.H.Sloboda

539.2 : 548.5

13943 ON THE PRESENCE OF NaOH IN CRYSTALLINE NaCl.

D.A.Otterson.

J. chem. Phys., Vol. 33, No. 1, 227-9 (July, 1960).

The alkalinity of NaCl crystals from various sources is reported, and the method of its determination described. Melt-grown crystals are usually more alkaline than natural rock salt. The alkalinity may vary in a melt-grown crystal. The alkalinity appears in melted salt, probably as a result of hydrolysis which produces NaOH and possibly by a reaction capable of liberating chlorine.

539.2 : 548.5

13944 SEGREGATION AND DISTRIBUTION OF IMPURITIES IN THE PREPARATION OF GERMANIUM AND SILICON.

J.Goorissen.

Philips tech. Rev., Vol. 21, No. 7, 185-95 (1959-60).

Two methods are described (variants of the zone-melting technique) for preparing "doped" single crystals. These methods yield a product in which the concentration of the impurity is uniformly distributed.

539.2 : 548.5

13945 APPARATUS FOR THE STUDY OF RECRYSTALLIZATION RATES.

H.P.Leighly, Jr.

Rev. sci. Instrum., Vol. 31, No. 7, 752-3 (July, 1960).

The apparatus was constructed to permit the determination of metal recrystallization rates at elevated temperatures. The experiment is accomplished by diffracting an X-ray beam from a specific crystallographic plane in a deformed single crystal and detecting with a scintillation counter. When the deformed material recrystallizes, the newly formed crystals have different orientations from that of the original crystal which prevents diffraction of the X-ray beam. By repeating this test at different points a known distance apart on the specimen, the rate of recrystallization can be calculated.

539.2 : 548.5

13946 THE GROWTH OF CRYSTALS IN POROUS MEDIA.

V.Ya.Khaimov-Mal'kov.

Kristallografiya, Vol. 3, No. 4, 488-93 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 487-93 (July - Aug., 1958).

The conditions for the growth of crystals in porous media are examined. The growth of crystals in the interior and on the surface of a porous medium was studied experimentally. The crystallization pressure during the growth of alum crystals on silica gel was measured.

539.2 : 548.5

13947 GROWTH FROM THE MELT. I. INFLUENCE OF SURFACE INTERSECTIONS IN PURE METALS.

G.F.Bolling and W.A.Tiller.

J. appl. Phys., Vol. 31, No. 8, 1345-50 (Aug., 1960).

The solid—liquid interface shape during growth from the melt has been determined for pure materials in the vicinity of external and internal surfaces; both the cases of isotropy and anisotropy of solid—liquid interfacial energy have been considered. From these considerations it is possible to determine some effects associated with interface and external surface anisotropy. For example, a preferred direction of growth, a surface layer phenomenon and stray-crystal formation during seeding and normal crystal growth may arise as a result of the solid—liquid interface configuration.

539.2 : 548.5

13948 GROWING ALUMINIUM SINGLE CRYSTALS OF KNOWN ORIENTATION FROM THE MELT.

D.E.Owsijenko and E.I.Sosnina.

Exper. Tech. der Phys., Vol. 8, No. 1, 40-2 (1960). In German.

A Bridgeman method was used to grow Al crystals of known orientation in vacuum with and without cleaved mica to act as seed. Orientated single crystal plates were also grown and the orientation depended on the growth rate.

J.E.Caffyn

539.2 : 548.5

13949 STUDY OF THE CRYSTALLIZATION OF ANTIMONY IN THIN FILMS. I. α- AND β-TRANSFORMATIONS.

L.S.Palatnik and V.M.Kosevich.

Kristallografiya, Vol. 3, No. 6, 709-15 (Nov.-Dec., 1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 716-21 (Jan., 1960).

The slow change of amorphous Sb films into a crystalline phase (α-transformation) and the sudden crystallization (β-transformation) were investigated. The time to complete the α-transformation and the growth rate of the crystalline spherulites were measured for different film thicknesses. The dependence of the α- and β-transformations on film thickness and condensation rate was obtained and the mechanism of these processes is discussed.

J.E.Caffyn

539.2 : 548.5

13950 LOW TEMPERATURE RECRYSTALLIZATION OF COPPER.

R.I.Garber, I.A.Gindin, B.G.Lazarev and Ya.D.Starodubov.

Fiz. tverdogo Tela, Vol. 2, No. 6, 1096-8 (June, 1960). In Russian.

Copper tubes of 1.5 mm external diameter and 0.6 mm internal diameter were deformed at 20° and 4.2°K by compression perpendicular to the tube axis. They were then left for 10-15 hours at room temperature and examined by sectioning. Recrystallization was observed, some of the grains intergrowing through boundaries of contact between two surfaces of the deformed specimens.

R.F.S.Hearmon

539.2 : 548.5

13951 NUCLEATION AND GROWTH OF MERCURY CRYSTALS AT LOW SUPERSATURATION.

G.W.Sears.

J. chem. Phys., Vol. 33, No. 2, 563-7 (Aug., 1960).

It is shown that mercury crystals can be nucleated on a cold glass surface at a much lower supersaturation than has been previously reported. The role of ambient temperature in the growth process is described. It is established that the growth habit is intrinsic to the pure mercury and is not characteristic of a growth modification by foreign gases.

539.2 : 548.5 : 537.2

GROWING CRYSTALS OF L-RHAMNOSE MONOHYDRATE.

See Abstr. 13650

539.2 : 548.5 : 537.2

13952 GROWING OF TERPINE MONOHYDRATE CRYSTALS AND THEIR ELASTIC AND PIEZOELECTRIC PROPERTIES.

I.M.Sil'vestrova, K.S.Aleksandrov and A.A.Chumakov.

Kristallografiya, Vol. 3, No. 3, 386-7 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 388-90 (May-June, 1958).

Large (30-50 g) equidimensional crystals were grown from gently stirred ethyl alcohol and acetone solutions by undercooling 1 to 2°C below saturation point. Observations indicate that terpine monohydrate belongs to the rhombic pyramidal class mm. Measurements of the dielectric, piezoelectric and elastic constants were made by dynamic methods which are very briefly described. All the data are presented and show in particular that the crystals are strongly piezoelectric.

A.E.Kay

539.2 : 548.5

13953 GROWING SINGLE CRYSTALS OF THE YTTRIUM FERRITE.

A.G.Titova.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1871-3 (Dec., 1959). In Russian.

Using a modification of the method of Nielsen and Dearborn (Abstr. 922 of 1959) the author has grown single crystals of the yttrium—iron garnet ferrite $Y_3Fe_5O_{12}$ up to 12 mm in linear dimensions. These were grown from a molten solution of the components of the substance in some solvent, which for Nielsen and Dearborn was simply PbO. The increased size was achieved by adding boric acid, which becomes B_2O_3 at the high temperatures used. The largest crystals were obtained with a melt containing 4-8 mol. % B_2O_3 and 44-48 mol. % PbO. It is believed that the growth of crystals is facilitated by the reduced viscosity of the molten material caused by adding B_2O_3.

N.Davy

539.2 : 548.5

13954

UPTAKE OF CAPRI BLUE BY GROWING LEAD NITRATE CRYSTALS.

I.M.Melankholin and E.N.Slavnova.

ristallografiya, Vol. 4, No. 4, 563-70 (July-Aug., 1959). In Russian. nglish translation in: Soviet Physics—Crystallography (New York), ol. 4, No. 4, 529-34 (April, 1960).

Spectroscopic studies on the uptake of Capri blue by growing ad nitrate crystals are reported; the adsorption curve is given. he habit of the grown crystal depends on the initial dye concentrat-on. The spectra of the crystals show that the dye is present as ubmicroscopic crystals. The positive growth tetrahedra may be fferentiated from the negative ones by examining the optics of the ystals.

539.2 : 548.5

13955

CONTROLLED CRYSTALLIZATION OF MELTS CONTAINING IMPURITIES. I.

O.Kulik and G.E.Zil'berman.

ristallografiya, Vol. 4, No. 4, 613-17 (July-Aug., 1959). In Russian. nglish translation in: Soviet Physics—Crystallography (New York), ol. 4, No. 4, 572-5 (April, 1960).

The impurity distribution in a pulled crystal is considered for ie case in which diffusion rather than convection controls the ransport of impurity. The result is an integral equation, which is olved by iteration. The solution is expressed in terms of two imensionless parameters.

539.2 : 548 5

13956

THE ROLE PLAYED BY LIQUID-PHASE DROPS IN CRYSTAL GROWTH AND EVAPORATION.

E.D.Du

ristallografiya, Vol. 3, No. 5, 605-11 (Sept.-Oct., 1958). In ussian. English translation in: Soviet Physics—Crystallogra ew York), Vol. 3, No. 5, 611-17 (Dec., 1959).

Certain aspects of the growth of layers with cusps arc nd a new effect is described in which drops of the melt part the evaporation from the surface of a paratoluidine crystal.

539.2 :

13957

SPIRAL GROWTH AND SOLUTION OF CRYSTALS.

M.I.Kozlovskii.

Kristallografiya, Vol. 3, No. 4, 483-7 (1958). In Russian. English ranslation in: Soviet Physics—Crystallography (New York), Vol. 3, o. 4, 481-6 (July - Aug., 1958).

The processes of the transition from the growth of crystals of -methylnaphthalene from ethyl alcohol solution to their solution vere studied. It is shown that the transformation from a growth piral to a solution spiral is similar to the transition from a spiral f growth from vapour to an evaporation spiral. An equation describing these processes is derived and discussed.

539.2 : 548.5

13958

ON THE OBSERVATION OF MACROSCOPIC SPIRALS ON GALLIUM ARSENIDE SURFACES.

.J.Little and K.A.McCarthy.

. appl. Phys., Vol. 31, No. 7, 1298-9 (July, 1960).

Spirals result from a "mistake" in the covalent bonding which ccurs during growth from the (111) surfaces of III-V compounds. o such mistake exists on $(\bar{1}\bar{1}\bar{1})$ surfaces and no spirals are bserved on them. A photograph illustrates the process on GaAs.

C.Hilsum

539.2 : 548.5

13959

THE GROWTH OF SULPHIDE LAYERS ON COPPER.

Y.N.Trehan and A.Goswami.

rans Faraday Soc., Vol. 55, Pt 12, 2162-5 (Dec., 1959).

The growth of sulphide layers on a Cu (110) face and also on olycrystalline copper by reaction with sulphur vapour at about 00° C was progressively studied by electron diffraction. Two new ubic sulphides ($a_0 \cong 33.51$ A and 4.338 A) were also observed as ntermediate products during the completion of reaction to CuS covellite).

539.2 : 548.5

13960

NEEDLE GROWTH IN THE OXIDATION OF COPPER. II.

L.Albert and W.Jaenicke.

.Naturforsch., Vol. 15a, No. 1, 59-65 (Jan., 1960). In German.

For Pt I, see Abstr. 6331 of 1960. It is shown that 75% of the eedles produced during the oxidation of copper at 500° C are overed in by the concurrently growing oxide layer, most of the eedles as a result of inhibition achieving only a small length. On he other hand, the length distribution of the needles is not substantially influenced by the layer growth. The weaker falling away of the length distribution curves found with increasing oxidation time is ascribed to absorption, in the growing oxide skin, of inhibitor impurities from out of the copper. Thickness distribution and thickness growth are discussed.

W.Good

539.2 : 548.5

13961

GROWTH AND EVAPORATION RATE OF NEEDLE-LIKE POTASSIUM CRYSTALS.

W.Dittmar and K.Neumann.

Z. Elektrochem., Vol. 64, No. 2, 297-305 (1960). In German.

A droplike single crystal was formed by condensation of potassium on a silver wire and examined microscopically. In supersaturated vapour the rate of lengthwise growth exceeds the rate of condensation. The product of the surface diffusion coefficient and the adsorption is calculated from the rate of growth and in agreement with earlier work [Z. Elektrochem., Vol. 63, 737 (1959)] is some powers of 10 greater in magnitude than that calculated using standard theories. In weakly undersaturated vapour the crystal grows quickly from the tip, and at a critical saturation of 50% the rate of growth drops suddenly to zero. The free surface energies of the (011) faces, ranging from 170 to 66 erg/cm², are evaluated.

S.Weintroub

539.2 : 548.5

13962

PREPARATION OF PURE TIN BY MULTIPLE ZONE REFINING COMBINED WITH PROLONGED VACUUM HEAT TREATMENT.

B.N.Aleksandrov.

Fiz. Metallov i Metallovedenie, Vol. 9, No. 1, 53-6 (1960). In Russian.

Sn of 99.99998% purity was produced by 12 hr treatment at 00° C in high (~ 10^{-5} mm Hg) vacuum, followed by multiple (55 ns) zone refining. The degree of purity of the Sn was determined the ratio of its electrical resistivity at 4.2° K to that at room perature.

M.H.Sloboda

539.2 : 548.5

13963

REFINING TELLURIUM BY THE ZONE MELTING TECHNIQUE.

N.F.Shvartsenau.

Fiz. tverdogo Tela, Vol. 2, No. 5, 870-3 (May, 1960). In Russian.

Taking the ratio of the electrical resistance at -196° C to that at 20° C as the measure of the purity of Te, it was shown that the impurity content in Te can be reduced from 1.0% to less than 0.0001% by zone refining in dry H, obtained by electrolysis of a KOH solution. The hole concentration in Te, purified by this method (9 runs, the molten zone 3-4 cm long, rate of travel 6 cm/h), was 2×10^{15} cm^{-3}.

M.H.Sloboda

539.2 : 548.5

13964

CLEAVAGE WHISKERS.

J.D.Venables.

J. appl. Phys., Vol. 31, No. 8, 1503 (Aug., 1960).

Whiskers have been obtained after cleaving a variety of materials; studies with optical and electron microscopes indicated that the whiskers originate in cleavage steps. Si and InSb whiskers thus obtained were single crystals ranging in size from 5000 to <500 A. The mechanism of formation is discussed.

J.Franks

539.2 : 548.5

13965

A COMPARISON OF ETCHING AND FRACTURING TECHNIQUES FOR STUDYING TWIN STRUCTURES IN Ge, Si AND III-V INTERMETALLIC COMPOUNDS.

J.W.Faust, Jr, and H.F.John.

J. Electrochem. Soc., Vol. 107, No. 6, 562-4 (June, 1960).

By a judicious choice of etchant the authors are able both to locate a twin boundary and also to determine the orientation relationship across the boundary. Three such etching methods together with a method of revealing twins by fracturing are discussed.

R.Bullough

539.2 : 548.5

13966

EFFECT OF Cu PRECIPITATION ON DISLOCATION ETCH PITS IN Ge.

H.Savage.

J. appl. Phys., Vol. 31, No. 8, 1472-3 (Aug., 1960).

Measured quantities of copper were introduced into n-type germanium single crystals by diffusion. Subsequently, both quenching and annealing heat treatments were performed on the samples. The effect on etch pit sizes and resistivity was recorded. It is shown that saturation with copper does not inhibit completely the formation of etch pits, although they are altered in size.

539.2 : 548.5

13967 THE STRUCTURE OF ETCHED SURFACES OF INDIUM ANTIMONIDE CRYSTALS. B.Kołakowski.

Acta phys. Polon., Vol. 18, No. 3, 205-14 (1959).

Monocrystals and polycrystalline samples were investigated. The etched figures obtained on surfaces of different crystallographic orientation had the shape of furrows changing in width and shape. The patterns obtained on the surfaces are not the result of the existence of a superstructure. Their occurrence can be explained possibly by a tendency of the boundary of the phases of the crystal surface and the etching medium to attain minimum energy.

539.2 : 548.5

13968 DISSOLUTION KINETICS AT DISLOCATION ETCH PITS IN SINGLE CRYSTALS OF LITHIUM FLUORIDE.

M.B.Ives and J.P.Hirth.

J. chem. Phys., Vol. 33, No. 2, 517-25 (Aug., 1960).

The kinetics of dissolution at dislocation etch pits in dilute aqueous solutions of ferric fluoride were studied by interferometric observations on etched surfaces. The effects on dissolution of the variables time, temperature, undersaturation, crystal perfection, and crystal orientation were determined. It was found that dissolution was consistent with the mechanistic theories of crystal dissolution involving dissociation of lithium fluoride from monomolecular ledges on closepacked surfaces and subsequent diffusion into solution, if a time-dependent adsorption of inhibitor at the receding ledges is invoked.

539.2 : 548.5

13969 ON ETCHING EFFECTS IN TANTALUM.

R.Bakish.

Planseeber. für Pulvermetall., Vol. 8, No. 2, 54-7 (Aug., 1960).

Etching effects are discussed which are believed to be associated with the delinention both of sites where dislocation lines emerge on the surface and of dislocation line segments on the exposed surface itself. Usual and special configurations, as well as changes due to cold work and heat treatment, are presented. Arguments to support the interconnection between etching effects and dislocations are also given.

539.2 : 548.7

13970 BRITISH ACHIEVEMENTS IN X-RAY CRYSTALLOGRAPHY. W.L.Bragg.

Science, Vol. 131, 1870-4 (June 24, 1960).

Survey article.

539.2 : 548.7

13971 A HORIZONTAL ELECTRON DIFFRACTION CAMERA "EG". B.K.Vainshtein and Z.G.Pinsker.

Kristallografiya, Vol. 3, No. 3, 358-61 (1958). In Russian. English translation in Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 358-61 (May-June, 1958).

The specimen-to-screen distance is 70 cm and the operating voltage is up to 75 kV. Some details of construction of the camera and electron gun are given.

A.R.Stokes

539.2 : 548.7

13972 HIGH VACUUM HIGH TEMPERATURE X-RAY CAMERA. B.A.Hatt, P.J.C.Kent and G.I.Williams.

J. sci. Instrum., Vol. 37, No. 8, 273-6 (Aug., 1960).

A camera suitable for the examination of reactive metals such as titanium and zirconium up to temperatures of 1000° C in vacuum better than 1×10^{-6} mm of mercury is described. The high vacuum is obtained by constructing the camera in glass without demountable seals, and the use of a radiant heater in place of a conventional furnace assembly. Application of the camera to studying the β—α transformation in Ti—Cr and Ti—Zr alloys is described.

539.2 : 548.7

13973 THE PRECISE DETERMINATION OF THE CAMERA RADIUS BY X-RAY DIFFRACTION PHOTOGRAPHS.

S.V.Borisov and V.P.Golovachev.

Kristallografiya, Vol. 3, No. 3, 384-5 (1958). In Russian. English translation in Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 386-7 (May - June, 1958).

An approximate value of the radius is refined by means of measurements of photographs taken with one specimen and with two different wavelengths. The lattice parameters of the specimen need not be known.

A.R.Stokes

539.2 : 548.7

13974. ELECTRONIC IMAGE INTENSIFICATION OF X-RAY DIFFRACTION PATTERNS.

R.E.Thun, J.Johnson, B.H.Krause and E.A.Meredith.

Analyt. Chem., Vol. 32, No. 8, 939-41 (July, 1960).

Studies of crystal structure transitions require diffraction equipment yielding a high time resolution. Extremely high power tubes and the sacrifice of angular scanning width on counter-diffractometers may not always be desirable. By using an electronic intensifier tube in a system with a gain of 100-200, an exposure of less than 10 sec could be achieved for photographic recording of the diffraction pattern. The system described uses Cu Kα radiation with a modified 11.46 cm powder camera which can take normal powder photographs for comparison. A circular segment of fluorescent screen covering a range of 2Θ from 90° to 140° intercepts part of the diffraction pattern. The fluorescent pattern on this screen is imaged by a fast lens onto an image-intensifier tube. The output from the intensifier is projected by a second lens onto high-speed panchromatic film. The total gain of the system compared to direct photographic recording is only 1×, but an improvement of the order of 10^2 is possible by improved lens and film choice. Cascading the intensifiers could produce even greater intensity gain.

R.V.Coates

539.2 : 548.7

13975 A SCINTILLATION COUNTER FOR SOFT X-RAYS, AND SOME RESULTS FROM ITS USE IN A HIGH-SPEED DIFFRACTOMETER. Yu.K.Ioffe and A.M.Sukhodrev.

Kristallografiya, Vol. 4, No. 4, 554-62 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol.4, No. 4, 521-8 (April, 1960).

Methods of increasing the speed and accuracy of diffractometry are demonstrated. A high-speed diffractometer that uses a scintillation counter is described briefly. This instrument records diffraction patterns eight times as fast as the URS-50I diffractometer, or alternatively, can treble the accuracy of the readings. Further ways of improving the instrument are indicated.

539.2 : 548.7

13976 CONSTRUCTION OF A LEAD CRYSTAL MONOCHROMATOR FOR NEUTRON DIFFRACTION STUDIES.

D.F.Litvin.

Kristallografiya, Vol. 4, No. 5, 663-7 (Sept.-Oct., 1959). In Russian English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 623-7 (May, 1960).

Large single crystals of lead were grown. A method was developed for the electric-spark cutting of plates from single-crystal ingots given orientation of the crystallographic axes.

539.2 : 548.7

13977 THE DETERMINATION OF THE ORIENTATION OF SINGLE CRYSTALS FROM LAUE DIAGRAMS.

S.S.Kvitka.

Kristallografiya, Vol. 3, No. 4, 519-20 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 525-6 (July-Aug., 1958).

The use of the "method of zonal development" of Kvitka and Umanskii is discussed, and it is shown that three Laue photographs are usually necessary. In some cases a cylindrical Laue photograph is advantageous rather than the more usual flat-plate. Details are given for the interpretation of photographs taken with the incident X-ray beam inclined at an oblique angle to the cassette axis.

R.V.Coates

539.2 : 548.7

13978 A SIMPLE METHOD OF PRECISE DETERMINATION OF THE LATTICE CONSTANTS OF POLYCRYSTALLINE SUBSTANCES WITHOUT THE USE OF STANDARDS.

B.M.Rovinskii and E.P.Kostyukova.

Kristallografiya, Vol. 3, No. 3, 382-3 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 383-5 (May-June, 1958).

In back-reflection powder diffraction photography it is difficult to measure accurately the specimen—film distance; even when a standard of accurately known lattice constant is used, the two substances may have unequal beam penetration, thermal expansion, and other experimental, differences. A method dispensing with the use of a standard substance yet giving high accuracy of lattice-constant determination is described. The approximate value of the parameter is found by other methods, and a suitable high-angle ring giving a close Kα_1, Kα_2 doublet chosen. The functions $(D/2A)_{\alpha 1}$ and $(D/2A)_{\alpha}$

e calculated from formulae given (where D is the ring diameter rresponding to a parameter a, and A the unknown specimen—film stance), over a range of a including the true value. The values of α_1 and $D\alpha_2$ are measured on the film, and can be put into the func- ons $(D/2A)_{\alpha_1}$ and $(D/2A)_{\alpha_2}$ enabling plots of A_{α_1} and A_{α_2} against a be made. The intersection of these two lines gives the true values A and a. R.V.Coates

539.2 : 548.7

13979 PRECISION MEASUREMENTS OF THE UNIT CELL PARAMETERS USING A DIFFRACTOMETER.

I.M.Umanskii, D.M.Kheiker and L.S.Zevin.
ristallografiya, Vol. 4, No. 3, 372-81 (May-June, 1959). In ussian. English translation in: Soviet Physics—Crystallography New York), Vol. 4, No. 3, 345-53 (March, 1960).

It is recommended that the position of diffraction peaks should e determined from the position of their "centers of gravity". method for the diffractometer measurement of the centres of ravity of peaks is discussed. In these cases it is necessary to se a wavelength which does not correspond to the maximum, but o the centre of gravity, of the spectral line. The corrections which nust be made in order to allow for variations in the Lorentz factor, olarization, and angular dispersion are discussed. A focusing nonochromator was mounted on the URS-50I goniometer, which xtended the recording range to $2\theta = 168^\circ$ and reduced the vertical ispersion of the beam. An example is given of the diffractometer neasurement of the parameter of the elementary cell of tungsten rom the position of the centre of gravity. Monochromatized uK_β radiation was used.

539.2 : 548.7

13980 METHOD FOR THE SIMULTANEOUS PRODUCTION, BY REFLECTION, OF ELECTRON DIFFRACTION ATTERNS OF AN INVESTIGATED SUBSTANCE AND A STANDARD.

u.I.Sozin.
ristallografiya, Vol. 3, No. 6, 748 (Nov.-Dec., 1958). In Russian. nglish translation in: Soviet Physics—Crystallography (New York), ol. 3, No. 6, 754-5 (Jan., 1960).

On one side of a thin wedge-shaped plate of very small angle here is a standard substance and on the other a substance to be nvestigated. This wedge is inserted in the primary electron beam o give two electron diffraction patterns, one on each half of the creen. J.E.Caffyn

539.2 : 548.7

13981 THE DETERMINATION OF THE PARAMETERS OF THE ANISOTROPIC TEMPERATURE FACTOR. A.A.Levin.

ristallografiya, Vol. 3, No. 4, 420-7 (1958). In Russian. English ranslation in: Soviet Physics—Crvstallography (New York), Vol. 3, lo. 4, 421-8 (July-Aug., 1958).

The anisotropic temperature factor is examined, together with ts connection with the anisotropy in the electron-density distribu- ion in atoms. A relationship is established between the parameters f the temperature factor and the anisotropy of the electron density. Vays of determining the principle values of the anisotropic tempe- ature factor are indicated

539.2 : 548.7

13982 THEORY OF X-RAY SCATTERING FROM MOSAIC CRYSTALS. A.G.Khachaturyan.

ristallografiya, Vol. 4, No. 5, 649-9 (Sept.-Oct., 1959). In Russian. nglish translation in: Soviet Physics—Crystallography (New York), ol. 4, No. 5, 606-10 (May, 1960).

Conditions are considered under which the coherence of cattering from blocks of a crystallite is disturbed. Rules are given or breaking the crystal up into regions of coherent scattering, de- ending upon the distortions of the lattice. In the general case, the ize of the region of coherent scattering decreases with increasing cattering angle, and there arises an additional angular dependence f the attentuaion. Part of the general attenuation follows a tan θ aw, as also does the attenuation in the case of the so-called distor- ions of the second kind, in which the quantity $\Delta d/d$ assumes the role f the angle of misorientation. In this case, it is not a simple matter o divide the effects of attenuation into effects due to distortion and ffects due to particle size.

539.2 : 548.7

13983 STUDY OF THE SCATTERING OF X-RAYS BY A LITHIUM SINGLE CRYSTAL. I. THEORY.

G.Champier.
Bull. Soc. Franc. Miner. Crist., Vol. 82, No. 1-3, 61-76 (Jan.- March, 1959). In French.

A summary is given of the theory of crystal lattice dynamics and of the scattering of X-rays. A spectrometer and a method of preparing lithium single crystal specimens are described. R.F.S.Hearmon

539.2 : 548.7

13984 STUDY OF THE SCATTERING OF X-RAYS BY A LITHIUM SINGLE CRYSTAL. II. RESULTS.

G.Champier.
Bull. Soc. Franc. Miner. Crist., Vol. 82, No. 4-6, 137-50 (April-June, 1959). In French.

See preceding abstract. Results of measurements are presented and used to calculate the elastic constants ($c_{11} = 1.00$, $c_{12} = 0.76$, $c_{44} = 0.70$ all × 10^{11} dyne/cm^2; see Abstr. 8925 of 1959). The specific heat is calculated and agrees with other determinations. Attention is drawn to the marked anisotropy of lithium and to some of its consequences. R.F.S.Hearmon

539.2 : 548.7

13985 THE HEXAGONAL SPACE GROUPS.

N.V.Belov.
Kristallografiya, Vol. 4, No. 2, 268 (March-April, 1959). In Russian. English translation in: Soviet Physics — Crystallography (New York), Vol. 4, No. 2, 251-8 (Feb., 1960).

The hexagonal crystal system has 12 classes, 12 point groups and two Bravais lattices but the number of hexagonal space groups is smaller than the number of tetragonal space groups even though the latter system also has only two Bravais lattices and only seven classes. The reason is that, in the hexagonal system, there are fewer ways of combining symmetry elements of the same type. The different combinations of symmetry elements in the hexagonal system are examined in detail and actual examples of most of the possibilities are quoted. J.Iball

539.2 : 548 7

13986 SPACE GROUPS AND FERROELECTRIC PHASE TRANSITIONS. A.S.Sonin and I.S.Zheludev.

Kristallografiya, Vol. 4, No. 4, 487-97 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 4, 460-9 (April, 1960).

It is shown that the space group changes according to a strictly defined law in a ferroelectric phase transition. The 230 space groups are considered in relation to such transitions.

539.2 : 548.7

13987 DERIVATION OF NEW SHUBNIKOV GROUPS.

A.M.Zamorzaev.
Kristallografiya, Vol. 3, No. 4, 399-404 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 401-6 (July-Aug., 1958).

The theory of Shubnikov groups and the method of their derivation from Fedorov groups obtain a new significance in connection with the concept of antisymmetry of a different kind, i.e., that based on assigning to the points of space several qualitatively different (+) or (–) signs. A complete derivation of generalized space translation and antitranslation groups is given, the results of a complete calculation of the generalized Shubnikov groups for the case of two signs are summarized and the prospects for further investigation are indicated.

539.2 : 548.7

13988 MORE ABOUT THE COLOUR SYMMETRY GROUPS.

N.V.Belov, E.N.Belova and T.N.Tarkhova.
Kristallografiya, Vol. 3, No. 5, 618-20 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 5, 625-6 (Dec., 1959).

The colour mosaics for the groups $I4_1(4_3)$ are discussed. These are built from sequences of blocks each having $P4_1$ symmetry and the blocks related by translations along the diagonals; 4_3 axes then occur at the meeting points of each set of four plates. Various square, tetragonal, and orthorhombic mosaics are shown and their derivation given. R.V.Coates

539.2 : 548.7

13989 THE SUPERSTRUCTURES POSSIBLE IN CLOSE-PACKED STRUCTURES. N.L.Smirnova.

Kristallografiya, Vol. 4, No. 1, 13-19 (Jan.-Feb., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 1, 10-16 (Jan., 1960).

General theoretical discussion of the many possible superstructures in any crystalline assembly based on units with close-packed structure. Many complicated assemblies are listed in tabular form. C.A.Hogarth

539.2 : 548.7

13990 POSSIBLE SUPERSTRUCTURES IN A SIMPLE CUBIC STRUCTURE.

N.L.Smirnova.

Kristallografiya, Vol. 4, No. 1, 20-4 (Jan.-Feb., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 1, 17-20 (Jan., 1960).

A theoretical investigation of a general nature, based on the laws of atomic coordination. Possible superstructures are estimated for metals, oxides, and intermetallic compounds.

C.A.Hogarth

539.2 : 548.7

13991 THE COVARIANT AND CONTRAVARIANT RELATIONS BETWEEN DERIVATIVE AND PARENT STRUCTURES.

N.V.Belov.

Kristallografiya, Vol. 4, No. 4, 618-19 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), No. 4, No. 4, 577-8 (April, 1960).

539.2 : 548.7

13992 POSSIBLE ARRANGEMENT OF ATOMS IN THE OCTAHEDRAL VOIDS IN THE HEXAGONAL CLOSE-PACKED STRUCTURE.

N.L.Smirnova.

Kristallografiya, Vol. 4, No. 5, 778-82 (Sept. - Oct., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 734-7 (May, 1960).

The possible arrangements of A and B atoms in the octahedral voids of a hexagonal close-packed structure of X atoms are examined. The X atoms are assumed to be surrounded by the same number of A and B atoms. Each X atom is situated in a three-sided prism of A and B atoms, whose six apexes can be occupied by the A and B atoms in three ways: (1) One apex by an A or B atom and the other five by B or A atoms, giving AB_5X_6 or A_5BX_6. (2) Two apexes by A or B atoms and four by B or A atoms, giving AB_2X_3 or A_2BX_3. (3) Three apexes by A atoms and three by B atoms, giving ABX_2. In real structures the A, B, or X atom-sites may be unoccupied. In each of the three cases all possible superlattices are calculated, and examples of actual compounds given for each one.

R.V.Coates

539.2 : 548.7

13993 QUANTITATIVE RELATIONS IN GENERALIZED FOURIER PROJECTIONS OF THE ELECTRON DENSITY OF CRYSTALS.

B.K.Vainshtein.

Kristallografiya, Vol. 3, No. 5, 527-38 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 5, 531-43 (Dec., 1959).

The shape of peaks on conventional (generalized) Fourier projections of the electron density of crystals is discussed. Formulae are derived for the calculation of the heights of these peaks, for the normalization of Fourier series of nonzero reciprocal-lattice planes, for the evaluation of the accuracy of values of electron density and also the horizontal and vertical coordinates of atoms on these projections. Modulus projections are also considered.

539.2 : 548.7

13994 THE DETERMINATION OF ELECTRON DENSITY DISTRIBUTION IN CRYSTALS.

N.N.Sirota, N.M.Olekhnovich and A.U.Sheleg.

Dokl. Akad. Nauk SSSR, Vol. 132, No. 1, 160-3 (May 1, 1960). In Russian.

A method is proposed for calculating the electron density distribution from the Fourier series formula, assuming that the density is made up of two contributions: (1) from the electrons near the atomic nuclei, and (2) from electrons in the outer parts of the atoms. The electron density distribution due to (1) is taken as Gaussian, and a simplified formula for total electron density is derived on this basis. Some calculations are made of electron density distribution in diamond.

R.F.S.Hearmon

539.2 : 548.7

13995 GENERALIZED BOUNDED ELECTRON DENSITY PROJECTIONS IN STRUCTURE ANALYSIS.

I.M.Rumanova.

Kristallografiya, Vol. 4, No. 2, 143-9 (March - April, 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 2, 127-33 (Feb., 1960).

A generalized bounded projection is defined as:

$$\int_{z_1}^{z_2} \rho(x,y,z) \begin{matrix}\sin\\ \cos\end{matrix}\left[\frac{2\pi Lz}{c}\right] dz,$$

where L is any real number. In particular, the class of projections is considered for which the coefficients of the Fourier series disappear very rapidly with increasing l. In the synthesis of such projections it is sufficient to have the structure amplitudes F_{hkl} from moving films of from two- to three- (at most four-) layer lines obtained by rotation about c, and they are therefore more convenient than the usual bounded projections, the construction of which necessarily requires a large selection of F_{hkl}.

539.2 : 548.7

13996 THE USE OF STRIPS FOR THE CALCULATION OF INTEGRALS OCCURRING IN FORMULAE FOR RADIAL DISTRIBUTION CURVES.

B.K.Vainshtein and L.I.Tatarinova.

Kristallografiya, Vol. 4, No. 5, 782-4 (Sept.-Oct., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 738-40 (May, 1960).

Problems in structure analysis often require the evaluation of spherical Fourier integrals of the type

$$F(r) = \int_0^{s_{max}} A(s)\ \frac{\sin sr.ds}{sr} \qquad \text{where } s = 4\pi\ \frac{\sin v}{\lambda}$$

If this is rewritten as the sum:

$$F(r) = \sum_{s_k=0}^{s_k=s_{max}} A(s_k)\ \frac{\sin s_k r_i}{s_k r_i}\ \Delta s_k$$

it is possible to use a strip summation technique similar to that of Beevers and Lipson, by preparing strips giving the values of $A\frac{\sin sr}{sr}$. A table of sin sr/sr is drawn up, using intervals of 0.2 for both Δs and Δr to give symmetry about the diagonal. Values of A of 1, 2, 3 ... 10, 20, 30, ...100 were selected so that by the use of two strips any amplitude from 1 to 100 could be obtained. To prepare the strips each line of the sin sr/sr table is multiplied by each value of A, rounding off values to the nearest unit. Specimen strips are shown, and practical details of lay-out and use are given. Three to four hours are needed for the calculation of a typical radial distribution curve.

R.V.Coates

539.2 : 548.7

13997 A METHOD OF ROTATING HARKER SECTIONS.

É.A.Gerasimova and S.S.Kvitka.

Kristallografiya, Vol. 3, No. 5, 629-31 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 5, 637-9 (Dec., 1959).

In some cases the pattern in the Harker section can be exactly the same as the electron density projection. However, Harker sections are not in general of great use in structure determination because of the large number of "false maxima" which arise for a cell containing many atoms. Since the positions of the true maxima are not independent, they can be shown up by bringing two or three rotated Harker sections into coincidence if the crystal has a fourfold or sixfold screw axis, when the true maxima will coincide. The method of constructing the rotated sections is described for the various four and six-fold screw axes, and applied to AlB_{12}, of space group $P4_12_1$.

R.V.Coates

539.2 : 548.7

13998 X-RAY DETERMINATION OF THE ORIENTATION OF A CRYSTAL.

A.I.Komkov and V.A.Frank-Kamenetskii.

Kristallografiya, Vol. 3, No. 4, 511-18 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 516-24 (July-Aug., 1958).

The construction of the projection of a plane and of a lattice row in an arbitrarily oriented crystal from a single Laue diagram, using the method of zonal development, is examined. Methods of determining the crystal symmetry and the orientation of the crystal from the projection are described.

539.2 : 548.7

13999 ELECTRON DIFFRACTION FROM THIN LAYERS OF COBALT DEPOSITED BY EVAPORATION ON A (111) FACE OF A COPPER SINGLE CRYSTAL.

J.Garigue, L.Lafourcade, Nguyen Quat Ti and F.Sonier.

C.R. Acad. Sci. (Paris), Vol. 250, No.20, 3296-8 (May 16, 1960). In French.

Cobalt was evaporated on to the (111) face of an electrolytically polished single crystal of copper, after cleaning up by bombardment with argon ions. Electron diffraction in situ showed that the deposit crystallized in either a face-centred cubic or hexagonal structure, r in a mixture of both. After a second evaporation, followed by eating by radiation, new reflections appeared which were due to obalt oxide. V.E.Cosslett

539.2 : 548.7

14000 X-RAY STUDY OF SOLID INCLUSIONS IN DIAMONDS.

S.I.Futergendler.

{ristallografiya, Vol. 3, No. 4, 494-6 (1958). In Russian. English ranslation in: Soviet Physics—Crystallography (New York), Vol. 3, Io. 4, 494-7 (July - Aug., 1958).

The following inclusions were found: garnet, olivine, diopside, hromospinellide and diamond.

539.2 : 548.7

14001 MOSAIC TEXTURE OF GRAPHITES.

E.G.Steward and B.P.Cook.

Iature (London), Vol. 186, 797-8 (June 4, 1960).

Lane patterns were found to demonstrate the existence of osaic units in graphitic carbons. J.Thewlis

539.2 : 548.7

14002 ON STRUCTURAL TYPES WITH CLOSEST ATOMIC PACKING. POSSIBLE STRUCTURAL TYPES WITH THE COMPOSITION AB_{12}.

N.L.Smirnova.

Kristallografiya, Vol. 3, No. 3, 362-4 (1958). In Russian. English ranslation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 362-4 (May-June, 1958).

Earlier papers by the author have dealt with structural types or the cases where A and B atoms are in closest packing with each A atom surrounded by 12 B atoms, and each B atom having 4, 3, or 2 neighbouring A atoms. This paper is concerned with each B atom aving only one neighbouring A atom. It is shown that this structural ype is possible only in the case of cubic close packing, and not in exagonal or mixed.

Space group $R\bar{3}$
$a_r = 1.581a_k$; $\alpha = 107^\circ\ 28'$
$a_h = 2.55a_k$; $c_h = 1.732a_k$
A in 3(a): 0, 0, 0
Bi in 18(f): x = 2/39, y = 7/39, z = 1/3
Bii in 18(f): x = 17/39, y = 1/39, z = 1/3

No actual compounds belong to this type. R.V.Coates

539.2 : 548.7 : 539.219

14003 AN X-RAY INVESTIGATION OF AGING IN ALUMINIUM ALLOYS. V. THE USE OF SPECIAL TYPES OF PHOTOGRAPH TO ELUCIDATE THE PECULIARITIES OF THE STRUCTURE OF ALLOYS.

Yu.A.Bagaryatskii.

Kristallografiya, Vol. 3, No. 5, 570-7 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 5, 574-81 (Dec., 1959).

For Pt IV, see Fiz. Metallov i Metallovedenie, Vol. 1, 330 (1955). It is shown that an X-ray small-angle oscillation photograph clarifies the form of the reflections in the zero layer of the reciprocal lattices and that the method of taking a photograph in a nonparallel beam reveals the form of the nonzero layers of the reciprocal lattice of a crystal. The methods indicated have been used to clarify certain peculiarities in the structure of the alloys Al—Cu and Al—Cu—Mg after aging.

539.2 : 548.7 : 539.219

14004 AN X-RAY INVESTIGATION OF AGING IN ALUMINIUM ALLOYS. VI. METHODS OF CALCULATING DIFFUSE SCATTERING.

Yu.A.Bagaryatskii.

Kristallografiya, Vol. 3, No. 5, 578-86 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 5, 582-91 (Dec., 1959).

Formulae are derived for calculating the intensity of diffuse scattering, suitable both for the stage of pre-precipitation, and for the stage where small regions of a second phase have been formed. A criticism is given of certain existing theories.

539.2 : 548.7 : 539.219

14005 X-RAY INVESTIGATION OF AGING OF ALUMINIUM ALLOYS. VII. ON THE STRUCTURE OF THE GUINIER—PRESTON ZONES IN ALUMINIUM—COPPER ALLOYS.

Yu.A.Bagaryatskii.

Kristallographiya, Vol. 4, No. 3, 341-7 (May-June, 1959). In Russian. English translation in: Soviet Physics — Crystallography (New York), Vol. 4, No. 3, 315-22 (March, 1960).

The experimental intensities are compared with a calculated distribution of intensities along the $[00\kappa]$ and $[11\kappa]$ lines in the reciprocal lattice of the alloy Al—Cu with 4% Cu, which was aged naturally. It is shown that Toman's calculated distribution of copper atoms and of displaced atomic planes in the Guinier—Preston zones does not agree well enough with the data obtained experimentally with the aid of a KFOR X-ray camera.

539.2 : 548.7

14006 ON THE CRYSTAL STRUCTURE OF $AlCl_3$.

K.Sasvári.

Acta phys. Hungar., Vol. 9, No. 1-2, 195-202 (1958).

The crystal lattice of $AlCl_3$ is derived on the basis of crystal-geometrical considerations starting from the dimension of the unit cell and from the fact that in the lattice (according to the electric conductivity measurements of Biltz and Voigt) there should be ionic bonds. The crystal lattice derived in this way proves to be the same as that given by Ketelaar et al. (1947). Therefore, it would seem that there cannot be Al_2Cl_6 molecules in the solid phase of $AlCl_3$, as has been suggested by Gerding and Smit (1941) on the basis of investigations of Raman spectra. A graphic representation is given for the mechanism of transition of the crystal lattice to the Al_2Cl_6 molecules of the liquid or vapour phase, and also for the mechanism of transition in the reversed direction.

539.2 : 548.7 : 539.19

14007 ELECTRON DIFFRACTION INVESTIGATION OF THE MOLECULAR STRUCTURES OF THE ALUMINUM HALIDES.

P.A.Akishin, N.G.Rambidi and E.Z.Zasorin.

Kristallografiya, Vol. 4, No. 2, 186-93 (March-April, 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 2, 167-73 (Feb., 1960).

Determined using sector electron diffraction techniques. The configuration and geometrical parameters of AlF_3 were obtained; the parameters for the dimer molecules aluminium chloride and aluminium bromide were determined more precisely. It was shown that aluminium iodide vapour consists mainly of monomer molecules of $Al\,I_3$; the degree of dimerization has been estimated, and the parameters have been obtained for the $Al\,I_3$ molecule.

539.2 : 548.7

14008 THE DENSITY AND LATTICE PARAMETERS OF RUBY.

J.P.Jan, S.Steinemann and P.Dinichert.

J. Phys. Chem. Solids, Vol. 12, No. 3-4, 349-50 (Feb., 1960).

The crystal lattice constants of 20 synthetic crystals of α-Al_2O_3 containing a concentration C_m (mol %) of Cr_2O_3 were measured. At 25°C the parameters were found to be $a = 4.7591\ (1 + 0.0527\ C_m)$ A (a to ±0.0004 and the constant to ±0.0016) and $c = 12.9894\ (1 + 0.0452\ C_m)$ A (c to ±0.0030 and the constant to ±0.0030). C_m extends up to 2%. $\rho = 3.9860\ (1 + 0.341\ C_m)$ g/cm^3 at 25°C (ρ to ±0.0004 and the constant to ±0.003). This agrees fairly well with the theory of the expansion as presented by Dinichert [Helv. Phys. Acta, Vol. 30, 463 (1957)]. A.L.Mackay

539.2 : 548.7

14009 A NEW COMPOUND IN THE SYSTEM Bi—Rh ESTABLISHED BY MEANS OF X-RAY DIFFRACTION.

G.S.Zhdanov, N.N.Zhuravlev, R.N.Kuz'min and A.I.Soklakov.

Kristallografiya, Vol. 3, No. 3, 373-4 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 374-5 (May-June, 1958).

Goniometric and X-ray diffraction investigations were made on crystals of Rode's β-Bi_4Rh. They had the same habit as Bi_3Ni crystals. From oscillation and Weissenburg photographs, the unit cell dimensions were found to be: a = 9.1, b = 4.2, c = 11.4 A (cf. Bi_3Ni: a = 8.875, b = 4.115, c = 11.477 A). The space group is D_{2h}^{16} – Pnma, as for Bi_3Ni. The measured density of the β-Bi_4Rh crystals was 10.7 g/cm^3, which leads to the incompatible value of 3 formula units per unit cell. If "β-Bi_4Rh" is isomorphous with Bi_3Ni, the existence in the Bi—Rh system of Bi_3Rh is assumed; the difference between Bi_4Rh and Bi_3Rh is only 3.1 wt % Rh. If β-Bi_4Rh is in fact Bi_3Rh, 4 formula units per cell are obtained, in agreement with Bi_3Ni. The close similarity in the intensities and reflections of the X-ray photographs of Bi_3Ni and Bi_3Rh is an additional argument for the isomorphism of the two phases. R.V.Coates

539.2 : 548.7

14010 ELECTRON DIFFRACTION STUDY OF THE ISOMETRIC CHROMIUM NITRIDE CrN.

Z.G.Pinsker and L.N.Abrosimova.

Kristallografiya, Vol. 3, No. 3, 281-7 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 285-91 (May-June, 1958).

Polycrystalline films of CrN, obtained by nitrogenation of condensed layers of Cr in an NH_3 current, were investigated. The existence of kinematic scattering of electrons ($\lambda \sim 0.05$ A) was established with high precision for two samples with crystallites ranging from 100 to 200 A in size. It is very probable that these samples are strongly deficient in nitrogen, in spite of the normal values of a = 4.14 A. Analysis and the use of different methods of determination of the nature of the bonds from the electron diffraction patterns evidently points to the presence of partial ionic bonding in CrN.

539.2 : 548.7

14011 X-RAY ANALYSIS OF THE STRUCTURE OF Cs_3Bi.

N.N.Zhuravlev and V.A.Smirnov.

Kristallografiya, Vol. 4, No. 4, 534-7 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 4, 503-6 (April, 1960).

Bismuth forms compounds $CsBi_2$ and Cs_3Bi with caesium; these compounds show peculiar electrical properties. The first becomes a superconductor at 4.75° K, while the second is a semiconductor and is used in photocathodes. The structure of $CsBi_2$ has been established as type Cu_2Mg (a = 9.746 ± 0.005 A). The atomic spacings in $CsBi_2$ are Bi—Bi = 3.43; Bi—Cs = 4.03; Cs—Cs = 4.22 A. Cs_3Bi found to be cubic of the Cs_3Sb structure, with a = 9.305 ± 0.006A, and all atomic spacings equal to 4.03 A. The different properties of $CsBi_2$ and Cs_3Bi are attributed to the differing Bi—Bi distances.

539.2 : 548.7 : 537.533

14012 EUROPIUM HEXABORIDE.

G.V.Samsonov, V.P.Dzeganovskii and I.A.Semashko.

Kristallografiya, Vol. 4, No. 1, 119-20 (Jan.-Feb., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 1, 109-10 (Jan., 1960).

EuB_6 was prepared by reduction of Eu_2O_3 with B_4C in vacuo at a temperature of 1650° C over a period of two hours. X-ray examination showed a cubic lattice with a = 4.163 ± 0.001 A, space group O_h and X-ray density 4.99 g cm^{-3}. The material had a thermionic work function of 4.90 eV with an emission constant of 1000-5000 A cm^{-2}. Its properties are compared with the other rare earth metal hexaborates. J.E.Caffyn

539.2 : 548.7

14013 A NEW CRYSTALLINE PHASE IN THIN FILMS OF Fe—Ni ALLOYS.

B.Ya Pines and I.P.Grebennik.

Kristallografiya, Vol. 3, No. 4, 461-6 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 460-4 (July-Aug., 1958).

The appearance of a new phase is reported. The unit cell has been determined; it appears to be orthorhombic (pseudohexagonal). Considerations of the possible arrangement of atoms in the unit cell are presented.

539.2 : 548.7

14014 AN INVESTIGATION OF THE STRUCTURE OF Fe_4N.

G.G.Dvoryankina and Z.G.Pinsker.

Kristallografiya, Vol. 3, No. 4, 438-43 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 439-44 (July-Aug., 1958).

An electron-diffraction study was carried out. The nitrogen atoms in the Fe_4N structure were located. The possibility of using an electron-diffraction photograph with an intermediate type of electron scattering in structural analysis was demonstrated.

539.2 : 548.7

14015 X-RAY DIFFRACTION STUDIES OF PILE-IRRADIATED HAFNUIM HYDRIDES.

S.S.Sidhu, F.P.Campos and D.D.Zauberis.

Nuclear Sci. Engng, Vol. 3, No. 6, 778-80 (June, 1958).

The structural stability of metal hydrides and deuterides in general and of hafnuim metal in particular, after exposure to pile radiations (thermal neutrons, epi-cadmium neutrons and gamma rays) is investigated. The main question is whether a metal hydride in which the metal atoms occupy positions that are different from those in the pure metal, due to bonding with hydrogen or deuterium atoms, would maintain its crystal structure or undergo a change when it is irradiated in the pile. The dose of pile flux that such a structure can stand is studied.

539.2 : 548.7

14016 X-RAY DIFFRACTION STUDY OF THE STRUCTURE OF IrSb.

R.N.Kuz'min.

Kristallographiya, Vol. 3, No. 3, 366-7(1958). In Russian. English translation in: Soviet Physics — Crystallography (New York), Vol. 3 No. 3, 367-8 (May-June, 1958).

The IrSb alloy having 61.33 wt% Ir was investigated, using less than 100 mg of material. The alloys were prepared in sealed quartz ampules, and annealed at 1500°C to give a microscopically homogeneous structure. Diffraction photographs were obtained in a RKU 114 mm diameter camera, using Cu Kα radiation. IrSb belongs to th NiAs structural type with a = 3.970, c = 5.510 kWX-units. A table is given of d_{calc} versus d_{exp}, and I_{calc} versus I_{exp}, for 46 reflections. The measured density was 13.5 g/cm^3 and the X-ray density 13.9 g/cm^3, with two formula units per cell. The most probable space group is D_{6h}^4-C5/mmc, with the atoms in 2-fold positions: 2 Ir in 000, $00\frac{1}{2}$; 2 Sb in $\pm(\frac{1}{3}, \frac{2}{3}, \frac{1}{4})$. R V.Coates

539.2 : 548.7

14017 NATURE OF THE CHEMICAL BOND IN CRYSTALLINE LiH.

Z.G.Pinsker and R.N.Kurdyumova.

Kristallografiya, Vol. 3, No. 4, 501-3 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 503-4 (July-Aug., 1958).

A study of polycrystalline films of LiH was made by electron diffraction. A three-dimensional potential series was computed in the (110) plane and from this the ratio of the Li and H potential peaks was found to be 2.98 whereas if the theoretical structure amplitudes are used the ratio is 2.23. It is concluded that the effect may be due to an increase of the negative charge of the H atom and a decrease for the Li atom. Thus there appears to be evidence of an appreciable $Li^+ H^-$ ionic bond in the structure. J.Iball

539.2 : 548.7

14018 THE TEMPERATURE FACTOR FOR SCATTERING OF X-RAY BEAMS IN A ROCKSALT CRYSTAL.

A.M.Ratner.

Kristallografiya, Vol. 3, No. 6, 740-1 (Nov.-Dec., 1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 744-6 (Jan., 1960).

The mean square displacements of the Na and Cl ions were calculated, by different methods of approximation, for temperatures below 40° K and above 90° K. Results are shown graphically for the range 0°-400° K. A.R.Stokes

539.2 : 548.7

14019 PRELIMINARY X-RAY INVESTIGATION OF THE STRUCTURE THERMISTOR MIXTURE OF NICKEL AND MANGANESE OXIDES.

T.Bedyńska.

Acta phys. Polon., Vol. 10, No. 3, 199-204 (1959).

The structure was investigated of a mixture of NiO and Mn_2O_3 (17 to 86.9%). It was found that in all the samples there occurs the cubic system of the space group O_h^7 with elementary cell dimensions close to those of the spinel of $NiMn_2O_4$ and changing with Mn_2O_3 content. In addition to the cubic system of the space group O_h^7, other phases occur which depend on Mn_2O_3 content.

539.2 : 548.7

14020 THE BORIDES OF PRAESODYMIUM, ERBIUM, AND TERBIUM.

G.V.Samsonov, Yu.B.Paderno and T.I.Serebryakova.

Kristallografiya, Vol. 4, No. 4, 542-4 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 4, 510-12 (April, 1960).

The borides were formed by reducing the oxides either with boron carbide or boron in an evacuated resistance furnace at temperatures between 1500° and 2000° C. The structures were found to be as follows: PrB_6, cubic, a = 4.12 A; ErB_4, tetragonal, (UB_4 structure) a = 7.08, c = 4.02 A; TbB_4, tetragonal, a = 7.13, c = 4.07 A; TbB_6, cubic, a = 4.11 A; Tables of d versus I are given for all four compounds. The work function of TbB_6 is 3.1 eV., corresponding to the configuration $4f^8 5d^1 6s^2$ for the terbium atom.
R.V.Coates

539.2 : 548.7

14021 VARIATION OF THE UNIT CELL PARAMETERS OF QUARTZ FROM DIFFERENT SOURCES.

N.A.Afanas'eva, I.E.Kamentsev and V.A.Frank-Kamenetskii.

Kristallografiya, Vol. 4, No. 3, 382-5 (May-June, 1959). In Russian.

glish translation in: Soviet Physics—Crystallography (New York), l. 4, No. 3, 354-7 (March, 1960).

Results are given of a precision X-ray analysis of 10 specimens natural quartz from different types of deposit. The parameters re determined with an accuracy of ±0.0002 A by the focusing ck-reflection method using a RKE camera. A variation of the rameter a, from 4.9121 to 4.9137 A and of the parameter c, om 5.4031 to 5.4051 A, was found. Comparison with the results spectrum analysis indicates the dependence of the volume of the it cell of quartz on the content of impurity (Al, R^+, R^{++}).

539.2 : 548.7

14022 **ELECTRON-DIFFRACTION INVESTIGATION OF TUNGSTEN NITRIDES.** V.I.Khitrova and Z.G.Pinsker.
ristallografiya, Vol. 3, No. 5, 545-52 (1958). In Russian. English anslation in: Soviet Physics—Crystallography (New York), Vol. 3, o. 5, 551-8 (Dec., 1959).

An electron-diffraction investigation of one of the phases of exagonal tungsten nitride with cell dimensions a = 2.89 A, c = 15.30 A as carried out. It was established that the structure is layer-like d may be described in the Federov group $D^4_{6h} - P6_3/mmc$. The ordinates of the tungsten and nitrogen atoms have been found. approximate composition was established for the samples of the tride investigated on the basis of an analysis of the heights of aks on a three-dimensional Fourier series of potential and by alysis of the agreement between experimental and calculated ructure amplitudes.

539.2 : 548.7

14023 **AN ELECTRON-DIFFRACTION STUDY OF CUBIC TUNGSTEN NITRIDE.** V.I.Khitrova and Z.G.Pinsker.
ristallografiya, Vol. 4, No. 4, 545-53 (July-Aug., 1959). In ussian. English translation in: Soviet Physics—Crystallography ew York), Vol. 4, No. 4, 513-20 (April, 1960).

A method of making cubic tungsten nitride free from other ases has been developed. The line profile given by electron-ffraction patterns has been analysed by harmonic analysis. The ructure has been shown to be of NaCl type by taking a section of e three-dimensional Fourier potential. The peak heights have en used, and R has been minimized (ultimately to 7.8%) to show at the composition of the samples probably lies between WN and $N_{0.67}$.

539.2 : 548.7

14024 **AN X-RAY STRUCTURAL PHASE ANALYSIS OF THE Zr—H AND Ti—H SYSTEMS.**
V.Sof'ina, Z.M.Azarkh and N.N.Orlova.
ristallografiya, Vol. 3, No. 5, 539-44 (1958). In Russian. English anslation in: Soviet Physics—Crystallography (New York), Vol. 3, o. 5, 544-50 (Dec., 1959).

It is found that the changes in structure on absorption of hydron are analogous in each system. With high hydrogen content a mogeneous range of a cubic β-phase is observed, which becomes tragonally distorted near the limiting composition ZrH_2 and TiH_2. e limits of this range do not correspond to a simple stoichioetric ratio between the components.

539.2 : 548.7

14025 **SOME REGULARITIES IN THE STRUCTURES OF TERNARY METALLIC COMPOUNDS.**
S.Palatnik and V.A.Finkel'.
ristallografiya, Vol. 3, No. 4, 467-72 (1958). In Russian. English anslation in: Soviet Physics—Crystallography (New York), Vol. 3, o. 4, 465-70 (July-Aug., 1958).

The relationship between the structure and the composition of rnary metallic compounds is investigated. The formation of ume-Rothery, Laves, nickel arsenide and sigma phases, as well as at of interstitial phases, is characteristic of ternary intermetallic stems for which the dependence of the type of structure on the tio between the radii of the nonmetals and metals is preserved one uses the mean value of the radius of metals, determined by egard's rule).

539.2 : 548.7 : 537.2

14026 **A CRYSTALLOCHEMICAL ANALYSIS OF THE THERMAL PHASE TRANSFORMATIONS IN FERRO-ND ANTIFERROELECTRICS WITH THE PEROVSKITE STRUCTURE.**
.N.Venevtsev and G.S.Zhdanov.
ristallografiya, Vol. 3, No. 6, 751 (Nov.-Dec., 1958). In Russian. nglish translation in: Soviet Physics—Crystallography (New York), ol. 3, No. 6, 759-60 (Jan., 1960).

The crystal symmetries of rare-earth aluminates (Abstr. 5539 of 1956) are shown to be in agreement with the authors' correlation of displacive transitions in ferroelectric and antiferroelectric perovskites, in terms of the Goldschmidt tolerance factor τ, and the "ferroactive" cation.

L.E.Cross

539.2 : 548.7

14027 **RADIAL DISTRIBUTION STUDY OF VITREOUS BARIUM BORATE.**
A.Bienenstock, A.S.Posner and S.Block.
J. Res. Nat. Bur. Stand., Vol. 64A, No. 3, 229-33 (May-June, 1960).

X-ray diffraction, radial distribution studies of a 20% barium oxide, 80% B_2O_3 glass have been performed using both the atomic and electronic distribution functions. From these distributions, the average barium—barium distance has been determined as 6.76 A. This distance is in good agreement with that predicted by Levin and Block (1957) on the basis of a structural interpretation of immiscibility data.

539.2 : 548.7

14028 **THE CRYSTAL STRUCTURE OF TRIBROMOBORON-SULFIDE.** Z.V.Zvonkova.
Kristallografiya, Vol. 3, No. 5, 564-9 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 5, 569-73 (Dec., 1959).

An X-ray study of the crystal structure of $Br_3B_3S_3$ was carried out. Interatomic distances B—S = 1.85, and B—Br = 1.93 A, and bond angles SBS = 102°, BSB = 138°, and SBBr = 129°, were found. An analysis is given of the nature of the chemical bonding in the structure.

539.2 : 548.7

14029 **THE CHEMICAL CRYSTALLOGRAPHY OF THE OXYGEN-VANADIUM BRONZES GIVEN BY GROUP-ONE ELEMENTS.** R.P.Ozerov.
Kristallografiya, Vol. 4, No. 2, 201-3 (March - April, 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 2, 181-3 (Feb., 1960).

The composition and existence of any given bronze are directly dependent on the size of the Group I atom. Na, K, Li, Cu, and Ag bronzes were made, but those of Rb and Cs were found impossible. Li and Cu atoms are the smallest in the series; all the alkali-atom sites are filled, which is not the case with the Na and K compounds. Hence, the first two bronzes contain twice the alkali metal content of the latter two, although all four are isomorphous. Rb and Cs bronzes were not made because, presumably, the sizes are too large to fit into the polyhedra available, and would need a more complex structure if their vanadium bronzes were to exist. Physical parameters are also affected by the size and ordering of the alkali atoms. The possible states of the valence electrons are considered.

R.V.Coates

539.2 : 548.7

14030 **THE STRUCTURES OF HERDERITE, DATOLITE AND GADOLINITE DETERMINED BY DIRECT METHODS.**
P.V.Pavlov and N.V.Belov.
Kristallografiya, Vol. 4, No. 3, 324-40 (May - June, 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 3, 300-14 (March, 1960).

The use of Harker—Kasper inequalities and of a statistical analysis by Zachariasen's methods is discussed in detail. Herderite, $CaBePO_4F$, is of special interest because it contains beryllium (15.3 wt % BeO, as against 14% BeO in beryl). Strunz (1949) has supposed that herderite has a structure very like that of datolite, $CaBSiO_4(OH)$, which Ito and Mori have examined (1953) by the (half) heavy-atom method; the two should form a good example of how ions of equal size, but different valency, having the same sum of all valencies for the groups (pairs), may replace one another to give the same structure:

$$CaBSiO_4\,(OH)$$
$$CaBePO_4F.$$

Gadolinite contains also Fe++: datolite is $Ca_2B_2(OH)_2Si_2O_8$, while gadolinite is $Fe^{++}Y_2Be_2O_2Si_2O_8$.

539.2 : 548.7

14031 **AN ELECTRON-DIFFRACTION STUDY OF $CuCl_2 \cdot 3Cu(OH)_2$.** A.A.Voronova and B.K.Vainshtein.
Kristallografiya, Vol. 3, No. 4, 444-51 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3. No. 4, 445-51 (July-Aug., 1958).

The structure is monoclinic, a = 5.73, b = 6.12, c = 5.63 A,

$\beta = 93^{\circ}45'$, Z = 1, space group C_{2h}^2. The copper atoms lie in the (100) plane in a pseudohexagonal arrangement. On either side of this plane are Cl atoms and OH groups forming a single densely packed layer, in the octahedra of which the Cu atoms lie. With the layer nature of the structure, the tendency towards square coordination of the copper atoms appears distinctly.

539.2 : 548.7 : 537.2

14032 CRYSTAL STRUCTURE OF FERROELECTRIC $LiH_3(SeO_3)_2$.

K.Vedam, Y.Okaya and R.Pepinsky.

Phys. Rev., Vol. 119, No. 4, 1252-5 (Aug. 15, 1960).

The structure of the room-temperature ferroelectric $LiH_3(SeO_3)_2$ was determined by X-rays, using the heavy-atom method, and refined on the IBM 704 computer. The crystals are monoclinic, with space group Pn and $a = 6.25_8$, $b = 7.88_6$, $c = 5.43_3$A, $\beta = 105.2^{\circ}$. Fairly strong O—H···O bonds with distances 2.52, 2.56 and 2.57 A are found, nearly perpendicular to the polar direction. The O—Se—O angles in one of the two selenite ions are rather similar; in the other ion these angles are unequal, as in the structure of H_2SeO_3. Possible positions for the Li ions are given based on crystal-chemical considerations.

539.2 : 548.7

14033 THE DETERMINATION OF THE STRUCTURE OF AMBLYGONITE BY THE MINIMUM-FUNCTION METHOD.

V.I.Simonov and N.V.Belov.

Kristallografiya, Vol. 3, No. 4, 428-37 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 429-38 (July - Aug., 1958).

A complete analysis of the structure of the lithium phosphate amblygonite, $LiAlPO_4F$, was carried out by the superposition method. A comparison is made of the resolving power of the various functions, which make it possible to clarify the crystallochemical nature of the part played by the lithium.

539.2 : 548.7

14034 REVISION OF THE STRUCTURE OF ASTRAKHANITE BY WEIGHTED PHASE PROJECTION METHODS.

I.M.Rumanova and G.I.Malitskaya.

Kristallografiya, Vol. 4, No. 4, 510-25 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 4, 481-95 (April, 1960).

Astrakhanite is monoclinic and its unit-cell parameters are a = 11.03, b = 8.14, c = 5.49 A, $\beta = 100^{\circ}39'$; the cell contains two $Na_2Mg(SO_4)_2 \cdot 4H_2O$ units, and the space group is $C_{2h}^5 = P2_1/a$. The structure has been derived by means of electron-density projections after the signs of the structure factors have been found by statistical methods. The coordinates have been revised by using weighted phase projection methods on the electron density. The structure consists of nets of Mg and Na octahedra parallel to xy; the nets are joined by SO_4 tetrahedra along z.

539.2 : 548.7

14035 X-RAY STUDIES OF THE METATANTALATES OF STRONTIUM, LEAD AND BARIUM AND OF THE (Pb, Ba, Sr, Ca)Nb_2O_6 AND (Pb, Sr, Ba)Nb_2O_6 SYSTEMS.

I.G.Ismailzade.

Kristallografiya, Vol. 4, No. 5, 658-62 (Sept.-Oct., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 618-22 (May, 1960).

Photographic and ionization methods have been used with CuK_{α} radiation to examine polycrystalline samples of $SrTa_2O_6$, $PbTa_2O_6$, $BaTa_2O_6$, and samples of (Pb,M)Nb_2O_6 (M = Ca,Sr,Ba) and (Pb, Sr, Ba) NbO_6. Below their Curie points $PbTa_2O_6$ (ferroelectric) and ferroelectric samples of (Pb, Ca)Nb_2O_6, (Pb, Sr)Nb_2O_6, (Pb, Ba)Nb_2O_6 and (Pb, Sr, Ba)Nb_2O_6 are isostructural to orthorhombic $PbNb_2O_6$. The lattice parameter of $PbTa_2O_6$ is given for the range from 22 to 280°C; above the Curie point that compound is tetragonal. At room temperature, $SrTa_2O_6$ and $BaTa_2O_6$ are isostructural to tetragonal $PbTa_2O_6$. This probably explains why those compounds are not ferroelectric.

539.2 : 548.7

14036 ELECTRON-DIFFRACTION DETERMINATION OF THE C—H DISTANCE IN SOME PARAFFINS.

B.K.Vainshtein, A.N.Lobachev and M.M.Stasova.

Kristallographiya, Vol. 3, No. 4, 452-60 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 4, 452-9 (July-Aug., 1958).

The C—H distance in paraffins is found to be equal to 1.123 ± 0.015 kilo X-unit, a value which is higher than the usually accepted one of 1.09 kilo X-unit.

539.2 : 548.7 : 537.

CRYSTAL STRUCTURE OF ETHYL AND VINYL STEARATE.

See Abstr. 13647

539.2 : 548.

14037 THE UNIT CELLS AND SPACE GROUPS OF PIEZOELECTRIC CRYSTALS OF $KHC_4H_4O_6$, $NH_4HC_4H_4O_6$, AND $C_6H_5CH(CH_3)NH_2C_4H_6O_6$.

Z.K.Zolina and A.D.Ershova.

Kristallografiya, Vol. 3, No. 3, 371-2 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 372-3 (May-June, 1958).

$KHC_4H_4O_6$ and $NH_4HC_4H_4O_6$ crystals are isomorphous, with the space group D_2^4—$P2_12_12_1$, and have 4 molecules per unit cell. $C_6H_5CH(CH_3)NH_2C_4H_6O_6$ has the space group C_2^2—$P2_1$, with 2 molecules per unit cell. The structurally equivalent ions lie in the general positions:- $KHC_4H_4O_6$: a = 7.594; b = 10.631; c = 7.747 kilo X-units. $NH_4HC_4H_4O_6$: a = 7.644; b = 11.061; c = 7.832 kilo X-units. $C_6H_5CH(CH_3)NH_2C_4H_6O_6$: a = 6.3; b = 14.2; c = 8.3 kilo X-units; $\beta = 119^{\circ}42'$. R.V.Coates

539.2 : 548.7

14038 FURTHER STUDIES OF LOW-ANGLE X-RAY DIFFRACTION PATTERNS OF COLLAGEN.

L.G.Ericson and S.G.Tomlin.

Proc. Roy. Soc. A, Vol. 252, 197-216 (Sept. 8, 1959).

Experiments were carried out on the drying of collagen fibres in vacuo at temperatures up to 200°C. Low-angle X-ray diffraction patterns of materials so treated differed markedly from those of collagen dried in vacuo at room temperature, which invalidates the comparison of the latter with density distributions observed by electron microscopy. One-dimensional Patterson functions plotted for a wide range of protein hydration, together with some evidence from electron microscopy, provided helpful pointers to the density distribution in dry collagen, and strong evidence in support of a model for wet collagen consisting of a rectangular density distribution function, such that each period along the fibril has a band of higher density and an interband of lower density. The width of the band was found to be 0.46 of the period by making use of results obtained by "staining" the fibres with heavy atoms. This model of the wet fibres, and the use of difference Patterson functions, made possible the elucidation of the effects of staining with silver nitrate, iodine, phosphotungstic acid, and osmium tetroxide. The major features of the distributions of these stains could be determined with results consistent with the observations of electron microscopy, for those stains detectable by this means. The diffraction method was successful in detecting heavy-atom staining not visible in the electron microscope. Each of the stains considered gave somewhat similar staining patterns, a prominent feature of which was a pair of dense bands 0.8d (d being half the collagen period) apart, at the ends of the wet collagen band. Most of the iodine which entered these particular sites was very easily removed, but some of it was more firmly bound in these and other positions.

539.2 : 548.7

14039 HYDROGEN BOND LENGTHS AND ANGLES OBSERVED IN CRYSTALS.

W.Fuller.

J. phys. Chem., Vol. 63, No. 10, 1705-17 (Oct., 1959).

Hydrogen bond lengths observed in crystals are classified according to the chemical groups participating in the hydrogen bond. Histograms are drawn for those types of bond for which there is sufficient data and the mean values of bond length for the various types of bond are given. Taking into consideration the accuracy of the data, the histograms are fairly sharp indicating that the length of a hydrogen bond (Y-H...Z) is largely determined by the nature of the hydrogen donor (Y-H) and acceptor (Z) groups. By contrast there appears to be little correlation between the length of a hydrogen bond and the angle at the donor atom between the hydrogen bond direction and the excepted direction of the bond to the hydrogen atom However hydrogen bonds are rarely formed if this angle is greater than 20°. If the mean values of bond length for bonds between a particular acceptor and various donors are arranged in order of increasing size, it is found that with few exceptions the resulting arrangement of donor groups is the same for all acceptors. The corresponding arrangements of various acceptor groups for each donor group are not quite so similar and suggest that the nature of the hydrogen donor may be more important than that of the acceptor in determining the hydrogen bond length.

539.2 : 548.7

14040 STRUCTURAL CHARACTERISTICS OF THE ELECTRONEGATIVITY OF ATOMS.

Z.V.Zvonkova.

Kristallografiya, Vol. 4, No. 5, 668-72 (Sept.-Oct., 1959). In Russian glish translation in: Soviet Physics—Crystallography (New York), l. 4, No. 5, 628-32 (May, 1960).

The establishment of a relationship between the distribution of ectron density and atomic distances has an important bearing on solution of a number of physico-chemical problems. New results e given on the more exact determination of the quantitative rela- nship between the electronegativities of atoms and experimental lues of atomic distances.

VARIOUS SOLID STRUCTURES

539.21

14041 APPARATUS FOR PHASE-EQUILIBRIUM MEASUREMENTS AT PRESSURES UP TO 50 KILOBARS AND EMPERATURES UP TO 1750° C. F.R.Boyd and J.L.England.
geophys. Res., Vol. 65, No. 2, 741-8 (Feb., 1960).

Construction and calibration of apparatus utilizing a solid essure medium for phase-equilibrium studies at elevated temperatures and pressures are described. Pressure calibration is rried out by measurement of the Bi I—Bi II and Tl II—Tl III ansitions. A new determination of the thallium transition, .1 ± 1.3 kilobars, is given. Tests indicate that talc is superior pyrophyllite and boron nitride as a solid pressure medium for gh-temperature work.

539.21

14042 COMPRESSION AND PHASE TRANSITIONS OF SOLID NH_3, SiF_4, H_2S, AND CF_4. J.W.Stewart.
. chem. Phys., Vol. 33, No. 1, 128-33 (July, 1960).

Isothermal PV curves were observed by the direct piston isplacement method up to pressures of 20 000 kg/cm^2 at various mperatures between 100° and 200° K. Relative volume changes nd compressibilities are given for each substance except CF_4. hase transitions were observed as discontinuities in the piston otion. NH_3 exhibits no phase transitions. Phase diagrams are iven for the other three substances. Comparison with previous ork in the case of H_2S shows only partial agreement. In some nstances the approximate volume changes accompanying the phase ansitions have been determined.

539.21

14043 DETECTION OF THE $\alpha-\gamma$ IRON PHASE TRANSFORMATION BY DIFFERENTIAL THERMAL CONDUCTIVITY ANALYSIS. W.F.Claussen.
ev. sci. Instrum., Vol. 31, No. 8, 878-81 (Aug., 1960).

A method of phase change detection in solids involving differential hermal conductivity analysis is described. This method is applied o the $\alpha-\gamma$ transformation of iron at various pressures up to 00 000 atm. This transformation temperature was found to drop ontinuously with increasing pressure down to 605° C at 100 000 atm.

539.21 : 539.17

14044 EFFECTS OF HIGH BURNUP ON NATURAL URANIUM. J H.Kittel and S.H.Paine.
uclear Sci. Engng, Vol. 3, No. 3, 250-68 (March, 1956).

Results are given from experiments in which unrestrained pecimens of unalloyed natural uranium were irradiated to total tom burnups ranging up to 1.82% at temperatures from 50° to 20° C. A few specimens were also thermally cycled. The specimens epresented material with four different fabrication histories: 1) rolled at 300° C; (2) rolled at 300° C and quenched from the beta hase; (3) rolled at 300° C, quenched from the beta phase, and recrystallized in the alpha phase; and (4) rolled at 600° C. It was found hat the 300° C rolled specimens in the as-rolled condition grew in ength at a rapid rate when subjected to irradiation, although they aintained relatively smooth surfaces. The growth rate of this aterial appeared to decrease with increasing irradiation temperaure. The beta-quenched specimens were much more stable imensionally but developed roughened surfaces. The 600° C rolled aterial showed intermediate behaviour. It was concluded that 00° C rolled and beta-quenched uranium can withstand at least atomic per cent burnup without disintegration due to irradiation amage. A qualitative similarity was found between the irradiation rowth rates of the four materials and their growth rates under hermal cycling.

539.211

14045 THE GEOMETRY OF SURFACE CRACKS. P.G.Morgan.
Appl. sci. Res. A, Vol. 9, No. 2-3, 148-52 (1960).

Surface cracking usually produces either irregular honeycombs or polygonal patterns. Such patterns are explained by using the principle of least work and assuming that the material, which is in the form of a plane surface, is homogeneous. Further it is assumed that during cooling the tension is uniform and increases progressively until the fracture strength is reached. A.E.Kay

539.211

14046 DETERMINATION OF SURFACE STRUCTURE USING ULTRA-HIGH VACUUM REPLICATION.
L.Bachmann, W.H.Orr, T.N.Rhodin and B.M.Siegel.
J. appl. Phys., Vol. 31, No. 8, 1458-62 (Aug., 1960).

Electron microscopy has been applied to the problem of characterizing the distribution of preferred sites for nucleation and growth on clean surfaces of evaporated films of magnesium metal. The films were deposited, platinum-shadowed, and carbon-backed in the same system under ultra-high vacuum conditions to minimize surface contamination and to improve the fidelity of surface replication. Upon examination of both clean and oxidized films in the electron microscope, the distribution of the platinum deposit was observed to be markedly influenced by the vacuum conditions used in the replication procedure. In addition, the particle size and separation of the platinum grains and their distribution, with relation to the substrate, indicated an enhanced surface mobility on cleaved mica and an apparent reaction on magnesium. These observations may have bearing on both the surface properties of metal deposits and on the development of high-resolution replication techniques.

539.211

14047 COMPARISON OF STRUCTURES OF SURFACES PREPARED IN HIGH VACUUM BY CLEAVING AND BY ION BOMBARDMENT AND ANNEALING. D.Haneman.
Phys. Rev., Vol. 119, No. 2, 563-6 (July 15, 1960).

A comparison was made of the structure of (0001) surfaces of Bi_2Te_3 produced by cleaving in high vacuum, with similar surfaces prepared by the ion-bombardment and annealing technique. The low-energy electron-diffraction patterns of the two surfaces were found to be similar and of approximately the same intensities. Only integral order beams were present. It is concluded that, for this crystal, both methods produce essentially clean surfaces with the same atomic arrangements. See also Abstr. 14151

539.213

14048 STUDY OF SHORT-RANGE ORDER IN AMORPHOUS SEMICONDUCTORS BY THE ELECTRON DIFFRACTION METHOD. L.I.Tatarinova.
Kristallografiya, Vol. 4, No. 5, 678-83 (Sept.-Oct., 1959). In Russian.
English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 5, 637-42 (May, 1960).

The semiconductor compounds As_2S_3, GaAs, and Sb_2Se_3 and Ge were studied by the electron diffraction method. It was found that the first two compounds retain in the amorphous phase the configuration inherent to them in the crystalline phase; in the case of amorphous Sb_2Se_3, the Sb-Se distance is 2.45 A, which is much less than in the crystalline compound, and the coordination numbers of Sb and Se are 4.7 and 3.1, respectively. Amorphous germanium shows a tendency to an increase in the coordination number in the first sphere.

539.213 : 536.41

ON THE THERMAL EXPANSION AND GRÜNEISEN FACTOR OF VITREOUS SILICA. See Abstr. 12532

539.213 : 539.2 : 537 311

VITRIFICATION IN COMPLEX CHALCOGENIDES BASED ON As_2S_3 AND As_2Se_3. See Abstr. 13610

539.214

14049 MECHANICAL AND THERMAL PROPERTIES OF POLYMERS IN THE SOLID STATE. I. CRITICAL ACCOUNT OF PREVIOUS CONTRIBUTIONS. R.Buvet.
J. Chim. phys., Vol. 57, No. 4, 255-64 (April, 1960). In French.

Present day knowledge of the mechanical and thermal properties of solid polymers is reviewed. The most recent methods of describing rheological properties where Boltzmann's superposition principle holds are summarized and there is a review of the experimental methods which cover the different ranges of relaxation time. A bibliographical review of recent experimental work is included (with 66 references) with emphasis on the effects of compressibility, the variation of mechanical properties with temperature and the interpretation of transition temperatures at ultrasonic frequencies.

R.G.C.Arridge

539.214

14050 MECHANICAL AND THERMAL PROPERTIES OF POLYMERS IN THE SOLID STATE. II. THEORETICAL AND EXPERIMENTAL STUDY OF A METHOD OF MEASURING VISCOELASTIC MODULI AT ULTRASONIC FREQUENCIES. R.Buvet.

J. Chim. phys., Vol. 57, No. 4, 265-75 (April, 1960). In French.

A method of measuring viscoelastic properties at ultrasonic frequencies is described, related to that of Nolle (Abstr. 3173 of 1948), based on the transmission of short pulses at oblique incidence. The method allows measurements of both compression and shear moduli to be made on the same specimen. The theory is presented together with experimental verification of the validity of the method. The apparatus is fully described.

R.G.C.Arridge

539.214

14051 MECHANICAL AND THERMAL PROPERTIES OF POLYMERS IN THE SOLID STATE. III. VISCOELASTIC PROPERTIES OF SOME POLYMERS AT ULTRASONIC FREQUENCIES. R.Buvet.

J. Chim. phys., Vol. 57, No.4, 276-86 (April, 1960). In French.

The results of measurements by the method described in Pt II (see preceding abstract) on polymethylmethacrylate, polyhexamethylene adipamide and a polyadipate of pentaerythritol are presented and discussed. In PMMA no second order transition could be observed in the curves of wave velocity versus temperature, contrary to recently published results. The shear and compression moduli showed nearly identical behaviour with both temperature and frequency. The results on polyhexamethylene adipamide were irreproducible and interpretation difficult. The polyadipate of pentaerythritol showed high dispersion and indicated nonapplicability of the theory of reduced variables. A molecular theory is presented embracing the different experimental results. The new information claimed to arise from this work is (1) The existence of compressibility and dispersion of compressibility providing a link between mechanical and dilatometric properties and (2) The absence of change of slope in the curves of viscoelastic moduli against temperature, limiting the appearance of a second order transition to experiments performed statically.

R.G.C.Arridge

539.214

14052 MEASUREMENT OF CRYSTALLINITY IN DRAWN POLYETHYLENE TEREPHTHALATE FIBRES BY X-RAY DIFFRACTION. G.Farrow and D.Preston.

Brit. J. appl. Phys., Vol. 11, No. 8, 353-8 (Aug., 1960).

A method has been devised for the measurement of crystallinity in drawn fibres of polyethylene terephthalate fibre by an X-ray technique. Strictly monochromatic X-ray radiation is used and the X-ray camera is evacuated. This enables the photographic film, which is used to record the X-ray reflexion, to be free of "white" radiation and parasitic X-ray radiation normally termed "air scatter". The results show that the crystallinity in drawn yarns is much lower than expected and that no correlation exists between the crystallinity so measured and the density of the yarns. The X-ray photographic method that has been developed is now comparable in speed with the alternative method of recording the X-ray diffraction pattern by means of a Geiger-Müller counter.

539.214

14053 LIGHT SCATTERING IN CRYSTALLINE HIGH POLYMERS; STUDIES ON SPHERULITES WITH RING-STRUCTURE. R.Dauscher, E.W.Fischer and H.A.Stuart.

Z. Naturforsch., Vol. 15a, No. 2, 116-22 (Feb., 1960). In German.

Light scattering experiments on thin films of melt crystallized polyethylene and polyethylene adipate are described. The spherulites seen under monochromatic polarized light show a system of concentric dark rings. The scattered light shows interference maxima out to the 4th-order, from which a grating constant d can be calculated, of value between 1 and 6 μ, in good agreement with microscopical measurements of the ring separation. A circular lattice model is considered from which are calculated the scattered light intensities for vertically and horizontally polarized light, under various conditions of polarizability and density fluctuations along the radius of the model. Comparison of the calculations with experiment favours the spiral lamella model of Keller as developed by Fischer, in preference to a shell model. It is concluded that the ring structure is caused by periodic variations of orientation rather than density.

R.G.C.Arridge

539.214

14054 THERMODYNAMIC STABILITY OF MACROMOLECULAR CRYSTALS. I. EFFECT OF THE LONGITUDINAL OSCILLATIONS OF CHAIN MOLECULES.

A.Peterlin and E.W.Fischer.

Z. Phys., Vol. 159, No. 3, 272-87 (1960). In German.

The free energy density of a chain crystal contains two terms of opposite sign, dependent on the number N of chain elements in the straight section of the macromolecules between the surfaces of the crystal perpendicular to the c-axis. The surface energy contributes a positive term decreasing with N. The amplitude ϕ of the periodic lattice field opposing the chain translation in the c-axis yields the negative term. Due to the incoherent longitudinal thermal vibration of the four first-order neighbours of any chain the field ϕ is smeared out. Its amplitude decreases the more the higher N and hence yields an increase in free energy density with increasing N. As a consequence of the opposite sign of surface energy and lattice field changes with N the free energy density shows a minimum at finite N corresponding to the thermodynamically stable crystal thickness. With increasing temperature and lower interaction between adjacent chains N increases in perfect qualitative agreement with experimental data.

539.215

14055 THE ANOMALOUS GROWTH OF METAL GRAINS IN VACUUM. L.S.Moroz and Yu.D.Khesin.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 2, 306-7 (March 11, 1960). In Russian.

Specimens of titanium, Armco iron and copper, annealed in vacuum, have larger grains throughout their thickness than corresponding specimens annealed in air. It is shown that the effect may be due to the removal in vacuum of low vapour pressure impurities.

R.F.S.Hearmon

539.215

14056 RECENT ADVANCES IN THE PREPARATION OF SINTERABLE URANIUM DIOXIDE. G.Imarisio.

Energia nucleare, Vol. 7, No. 7, 470-6 (July, 1960). In Italian.

The influence of different experimental conditions on the quality of the UO_2 obtained and on the sintered density is evaluated. The need for further researches in order to attain a full understanding about the sintering mechanism and in order to get more constant sizes of the sintered pellets is pointed out.

539.215

14057 ENRICHED BORON—TITANIUM DISPERSIONS. L.B.Prus, E.S.Byron, F.O.Von Plinsky and S.W.Porembk

Nuclear Sci. Engng, Vol. 6, No. 3, 167-73 (Sept., 1959).

A study of the extrusion and fabrication characteristics of various titanium-enriched boron dispersions indicate that hot extrusion of uncompacted powders is a feasible method for producing these materials. Tensile and impact properties of dispersions containing 2.43, 3.4, and 3.8 wt% B^{10} show a decrease with increasing B^{10} concentration. Irradiation studies on these materials revealed that internal cracking results after thermal neutron exposures of approximately 4.6×10^{20} nvt and higher. Tensile properties of the dispersions were related directly to the exposure and resulting structure, however, no correlation was found between exposure and impact properties of these materials.

539.215 : 536.2

HEAT-MASS EXCHANGE IN A LAYER OF BALLS.

See Abstr. 12514

539.216

14058 STRUCTURE OF HIGH-RANK COALS DEDUCED FROM HELIUM DENSITIES.

T.S.Polansky, H.J.Donald and C.R.Kinney.

Nature (London), Vol. 186, 792-3 (June 4, 1960).

The densities, corrected for the pressure of mineral matter, and specific volumes of a series of coals were plotted against H content. It was found in each case that graphite constituted the end point of the plot, which is not in agreement with the results of Franklin for specific volume. The result does, however, support the generally accepted view that coal molecules can be considered as islets of small graphite monolayers, and that the density of graphite represents the "true limit" of coalification.

J.Thewlis

539.217

14059 MOLECULAR SIEVES.
D.W.Breck and J.V.Smith.

American, Vol. 200, No. 1, 85-90. 92, 94 (Jan., 1959).

An account of the zeolite minerals, whose crystals contain a iad of minute pores (~ 10^{21} per in^3., ~ 4A diam.), which find a in bulk separation of very similar molecules, e.g. octane and -octane. Alternatively, gases like argon and nitrogen can be mped" into a zeolite, at very high pressures, which on cooling to ut −150° and −120°C respectively, traps the gases. The zeolite s forms a convenient storage device. Synthetic zeolites of a en "aperture" can be fabricated by partially blocking the apertures atoms of various sizes.

539.217

14060 PERMEABILITY OF POROUS MEDIA DURING FILTRATION OF AERATED LIQUIDS. D.A.Efros.

l. Akad. Nauk SSSR, Vol. 132, No. 2, 311-14 (May 11, 1960). ussian.

The coefficients of filtration for both liquid and gas phases of ated liquids depend on their saturation. Experimental graphs provided for filtration coefficients of both the free gas and for gas in liquid when filtrated through sand. Also the pressure ribution through the sand layer is illustrated as well as the other ameters determining the filtration efficiency. J.K.Skwirzynski

539.217

14061 DIFFUSION OF HYDROGEN THROUGH PALLADIUM MEMBRANES. A.J.De Rosset.

ustr. engng Chem., Vol. 52, No. 6, 525-8 (June, 1960).

Owing to the notable lack of data on the diffusion of hydrogen ough palladium at high pressures, and the possible uses of this meability for processing industrial gas streams, experiments described for obtaining diffusion rates under the conditions:)-850° F, 1-700 lb/in^2 upstream pressure, 0-300 lb/in^2 downstream ssure, hydrogen purity (66 and 99+, mole %), nondiffusible uents (N_2, CH_4), membrane area 0.0094 sq. ft., and membrane ckness 0.0008 in. It is found that hydrogen diffuses selectively rates over 250 standard cubic feet per hr. per square foot at ° F and a pressure drop of 400 lb/in^2; presence of up to 35% of rogen or methane does not interfere with the process. The fusion rate is proportional to pressure drop at low pressures, linear with the difference between the 0.8 power of pressure at h pressures. These relationships are associated with surface bulk-rate-controlling processes respectively. Deviation from normal square root of pressure law in the latter case correlates h high pressure solubility isotherms for the palladium-hydrogen stem. H.H.Hodgson

539.219

14062 THE EFFECT OF THE CONCENTRATION DEPENDENCE OF THE SEGREGATION COEFFICIENT ON RE- STRIBUTION OF THE COMPONENTS OF A BINARY SYSTEM RING DIRECTIONAL SOLIDIFICATION. V.N.Romanenko.

z. tverdogo Tela, Vol. 2, No. 5, 866-9 (May, 1960). In Russian.

Theoretical. Formulae are derived which, in contrast to those Pfann, can be used to determine the re-distribution of components binary systems during directional solidification in the case of h solute concentrations. M.H.Sloboda

539.219

14063 GENERAL THEORY OF ORDER IN n-COMPONENT ALLOYS. K.F.Wojciechowski.

ta phys. Polon, Vol. 18, No. 2, 153-60 (1959).

The statistical theory of order–disorder transformations for component alloys with arbitrary composition and crystalline ructure is given. The parameters of long-range and short-range der are defined and equations which hold for them are found. The nfigurational free-energy in zeroth and first approximations is lculated on the basis of generalized Bragg–Williams and quasi- emical methods. By taking into account the interaction of atoms om more distant shells than the first one it is possible to compute ore precisely the order–disorder transition temperature for an bitrary alloy.

539.219 : 539.2 : 548.7

X-RAY INVESTIGATION OF AGING ALUMINIUM ALLOYS.

ee Abstr. 14003

539.219

14064 INVESTIGATION OF THE RELATIONSHIP BETWEEN THE INTERNAL ADSORPTION AND THE ELECTRICAL RESISTANCE OF ALLOYS.

V.I.Arkharov, B.S.Borisov, S.D.Vangengeim and G.K.Sokolova.
Fiz. Metallov i Metallovedenie, Vol. 9, No. 1, 81-5 (1960). In Russian.

The electrical resistance R of Cu–Cd, Cu–In, Cu–Sn and Cu–Sb alloys in the work-hardened condition decreased after annealing at 400-600° C. Subsequent annealing at 800-900° C not only failed to further reduce R, but resulted in its increase, this effect having been attributed to desorption of the solute atoms in the region of intergranular, internal absorption. The increase in R was proportional to the difference z between the valencies of the alloy components. This relationship could be predicted from the Friedel's theory of electron screening, according to which the magnitude of the screening effect decreases with increasing z. Consequently, the difference between the states of the solute atoms at the grain boundaries and in the interior of the grains of alloys with large z is small, as a result of which the diffusion processes (internal adsorption and desorption), associated with redistribution of the solute atoms between these two regions, are slowed down. M.H.Sloboda

539.219

14065 CONSTITUTION OF THE CHROMIUM-TELLURIUM SYSTEM.

L.G.Gaidukov, V.N.Novogrudskii and I.G.Fakidov.
Fiz. Metallov i Metallovedenie, Vol. 9, No. 1, 152-5 (1960). In Russian.

Temperature dependences of the electrical resistivity and intensity of magnetization of Cr–Te alloys (containing 5-95 at.% Te), showed that two ferromagnetic phases, not revealed by microscopic examination, are present in alloys with 56-65 at.% Te. M.H.Sloboda

539.219

14066 WETTING AND ALLOYING STUDIES ON GERMANIUM.
M.Michelitsch.

Z. angew. Phys., Vol. 12, No. 4, 180-4 (April, 1960). In German.

Describes a simple easily reproducible wetting method, suitable for the wetting of indium and its alloys on to germanium at high temperatures. The oxide skin on the initial material is replaced by a halide layer, which is reduced at a reasonably high temperature in a hydrogen atmosphere, and provides a clean surface at least for the moment of wetting. G.C.Williams

539.219

14067 MUTUAL ORIENTATION OF THE α- AND σ-PHASES UPON THE DECOMPOSITION OF SOLID SOLUTIONS IN IRON–VANADIUM ALLOYS. M.I.Zakharova and N.A.Khatanova.

Kristallografiya, Vol. 3, No. 3, 376-8 (1958). In Russian. English translation in: Soviet Physics–Crystallography (New York), Vol. 3, No. 3, 377-80 (May-June, 1958).

X-ray and microscopic studies suggested that the σ-phase crystals are oriented with their fourfold axes parallel to the fourfold axes of the α-phase crystals, and that the [110] axes of the σ-phase are parallel to the [110] axes of the α-phase. J.Thewlis

539.219

14068 EFFECTS OF IRRADIATION ON CORROSION RESISTANCE OF SOME HIGH URANIUM ALLOYS.

S.Greenberg and J.E.Draley.
Nuclear Sci. Engng, Vol. 3, No. 1, 19-28 (Jan., 1958).

Three corrosion resistant uranium base alloys were corrosion-tested in high temperature water: U–5%Zr–$1\frac{1}{2}$%Nb, U–3%Nb–0.5%Sn, and U–3.8%Si. Only the U–3.8%Si alloy retained any degree of corrosion resistance after burnups in excess of 0.1 at.%. Low burnup did not adversely affect the corrosion resistance of the diffusion bond between U–2%Zr alloy and its Zircalloy-2 cladding.

539.219

14069 CORROSION OF IRRADIATED URANIUM ALLOYS.
S.Greenberg.

Nuclear Sci. Engng, Vol. 6, No. 2, 159 (Aug., 1959).

U-5% Zr-$1\frac{1}{2}$% Nb fuel alloy was heat-treated for dimensional stability under irradiation. This treatment comprised heating at 825° C, quenching at 640° C, holding at 640° C for 23 hr, and air cooling. In this condition the fuel material has a corrosion rate at 260° C in initially pure water of 9470 mg cm^{-2} day^{-1}. For comparison, the corrosion rate for unalloyed uranium under the same conditions is about 64 000 mg cm^{-2} day^{-1}.

539.219

14070 DIMENSIONAL STABILITY OF URANIUM—CHROMIUM ALLOYS. M.C.Fraser, G.A.Last and S.H.Bush.
Nuclear Sci. Engng, Vol. 4, No. 6, 794-7 (Dec., 1958).

Limited additions of chromium are known to have a marked effect on the mechanical properties of unirradiated uranium; however, little is known about the dimensional stability of such alloys when irradiated in a preferredly oriented condition. This study was made to evaluate the effect of various additions of chromium from 0 to 1 atomic per cent, covering the solid solubility region of chromium in alpha uranium at room temperature. The experiment was designed to hold grain size and type and degree of preferred orientation constant while varying the chromium content with concomitant changes in the tensile properties.

539.219

14071 A KINETIC STUDY OF IRRADIATION INDUCED PHASE CHANGES IN URANIUM—9 WT%MOLYBDENUM ALLOY. M.L.Bleiberg.
Nuclear Sci. Engng, Vol. 5, No. 2, 78-87 (Feb., 1959).

Uranium—molybdenum alloys have been shown to transform from the stable to the metastable phase due to neutron bombardment. This phenomenon has been explained on the basis of the smoothing out of concentration gradients due to the action of "displacement spikes" or "thermal pulses" generated within the sample. A kinetic study of this reaction in U—9 wt% Mo alloy specimens was performed in which the phase reversal was followed by electrical resistivity measurements on the samples while they were being irradiated and held at low temperatures in-pile. The special facility which was constructed to perform this work, as well as the results of the first in-pile experiment, are described. The results of this test are felt to verify the displacement spike model of radiation damage.

539.219

14072 SOME PROPERTIES OF URANIUM-FISSIUM ALLOYS. S.T.Zegler and M.V.Nevitt.
Nuclear Sci. Engng, Vol. 6, No. 3, 222-8 (Sept., 1959).

Hardness, density, and thermal expansion data are presented for alloys of uranium with certain fission-product elements. The elements are those expected to remain in a spent fuel from a fast reactor following pyrometallurgical refining. In cast and gamma quenched alloys the retention of the high-temperature gamma phase produces low hardness and low density. Thermal expansion behaviour is dependent upon composition and prior thermal history.

539.219

14073 DETERMINATION OF THE NUMBER OF INDEPENDENT PARAMETERS OF THE SHORT-RANGE ORDER IN MULTI-COMPONENT SOLID SOLUTIONS. A.N.Men'.
Fiz. Metallov i Metallovedenie, Vol. 9, No. 1, 19-23 (Jan., 1960).
In Russian.

Theoretical. A formula, taking into account the dependence of the short-range order σ on the distribution of atoms between sublattices, is derived for the number $N_{\sigma}^{(1)}$ of linearly-independent parameters of σ in a n-component system with a complex crystal lattice.
M.H.Sloboda

539.219

14074 SUBSTRUCTURE OF CRYSTALS OF THE γ-SOLID SOLUTION OF NICKEL IN IRON DURING POLYMORPHIC TRANSFORMATION. M.I.Zakharova and N.A.Khatanova.
Kristallografiya, Vol. 3, No. 3, 378-81 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 380-3 (May - June, 1958).

The transformation $\gamma \rightarrow (\gamma + \sigma)$ in an Fe—32% Ni alloy was studied by X-ray diffraction and photomicrography. The initial stage of the transformation was found to be martensitic, the α-phase (110) planes being parallel to the (111) planes of the γ-phase. Further growth of the α-phase was found to proceed by diffusion.
J.Thewlis

539.219

14075 DECOMPOSITION OF SOLID SOLUTIONS IN THE NICKEL—GOLD SYSTEM. I.
V.V.Sanadze and G.V.Gulyaev.
Kristallografiya, Vol. 4, No. 4, 526-33 (July-Aug., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 4, 496-502 (April, 1960).

Successive quenching was used to study alloys containing 0.7, 1.12 and 1.72 at. % gold. X-ray studies and measurements of microhardness and resistivity show that the gold-rich solid soluti formed by these alloys split up into two phases at comparatively l temperatures, while the nickel-rich solutions split up into two pha at 500-600° C.

539.2

14076 DECOMPOSITION OF SOLID SOLUTIONS IN THE NICKEL—GOLD SYSTEM. II.
V.V.Sanadze and G.V.Gulyaev.
Kristallografiya, Vol. 4, No. 5, 687-94 (Sept.-Oct., 1959).
In Russian. English translation in: Soviet Physics—Crystallogra (New York), Vol. 4, No. 5, 646-54 (May, 1960).

Alloys with a content of 3.2, 4.8 and 6.7 at. % gold were studi by X-ray diffraction analysis, and by microhardness and electrica resistance measurements. The successive quench method was us for ascertaining the decomposition of solid solutions from room temperature to 925° C.

539.2

14077 CONTINUOUS SERIES OF METASTABLE SOLID SOLUTIONS IN SILVER-COPPER ALLOYS.
P.Duwez, R.H.Willens and W.Klement,Jr.
J. appl. Phys., Vol. 31, No. 6, 1136-7 (June, 1960).

A technique has been devised by which small amounts of liqui alloys can be cooled at rates high enough to prevent normal processes of nucleation and growth of equilibrium phases. X-ray diffraction measurements on Ag—Cu alloys established that during solidification, the Cu and Ag rich stable phases did not have time to nucleate and grow, and metastable solid solutions were obtained
R.F.Pea

539.2

14078 METASTABLE ELECTRON COMPOUND IN Ag—Ge ALLOYS. P.Duwez, R.H.Willens and W.Klement,Jr.
J. appl. Phys., Vol. 31, No. 6, 1137 (June, 1960).

Use of rapid quenching techniques (see preceding abstract) on Ag—Ge alloys containing 25.7 at.% and 16.4 at.% Ge showed the existence of metastable phases with a c.p.h. structure at these concentrations. The lattice parameters are a = 2.987 ± 0.003, c = 4.716 ± 0.002 and c/a = 1.628 ± 0.003 for the former, and a = 2.891 ± 0.002, c = 4.718 ± 0.006 and c/a 1.632 ± 0.003 for the latter. The phases are considered to be 7/4 and 3/2 electron compounds respectively.
R.F.Pea

539.

14079 THIN FILMS CALCULATIONS USING THE IBM 650 ELECTRONIC CALCULATOR.
J.A.Berning and P.H.Berning.
J. Opt. Soc. Amer., Vol. 50, No. 8, 813-15 (Aug., 1960).

A general programme for the IBM 650 is presented for calcula ing the reflectance and transmittance of arbitrary multilayer combinations of absorbing and nonabsorbing films as functions of wavelength and angle of incidence. The basic formulas which are utilized in the calculations are given together with the essential details of the machine programme, including a macro-flow diagram

539.23

14080 STUDY OF THE CRYSTALLIZATION OF ANTIMONY IN THIN FILMS. III. INFLUENCE OF VARIOUS ADDITIONS. L.S.Palatnik and V.M.Kosevich.
Kristallografiya, Vol. 4, No. 5, 673-7 (Sept.-Oct., 1959). In Russia English translation in: Soviet Physics—Crystallography (New York Vol. 4, No. 5, 633-6 (May, 1960).

For Pt II,see Abstr. 738 of 1960. It is shown that additions of alum nium, beryllium and chromium increase the stability of the amorphous phase in condensed films of alloys with antimony, while additions of silver, gold, bismuth, copper, and tin accelerate crystallization. A connection is established between the influence of the same metals on t crystallization of antimony when they are in the form of additions and when they act as supports.

539.2

14081 METHOD FOR THE RAPID PREPARATION OF THIN FILMS OF METAL HALIDES. G.Perny.
J. Phys. Radium, Vol. 19, Suppl. No. 7, 119A-120A (July, 1958).
In French.

The metals are evaporated on to glass substrates in the prese of iodine vapour at a pressure of 0.5 mm Hg. The metals used wer Ag, Cu, Zn, Tl, In, Pb, Sn, and Ge. Films of AgBr and AgCl were prepared in the same way.
C.Hilsu

539.23

082 SUBMICROSCOPIC STRUCTURE OF ELECTROLYTIC Cu DEPOSITS. S.Steinemann and H.E.Hintermann.

veiz. Arch. angew. Wiss. Tech., Vol. 26, No. 5, 202-10 (May, 1960).
erman.

Various deposits were examined by transmission electron
roscopy. Without inhibitors, the grain structure and distortions
ocations) of the base are reproduced; cathode-active additives
included in various sized cavities of high and nearly constant
ity. Internal stresses are due to interactions with dislocations.
se growth faults determine the properties of deposits, and are
to electrochemical processes near and at the phase boundary.

539.23

4083 MEASUREMENT OF CRYSTALLITE SIZE AND STRAIN OF ELECTROPLATED FILMS. R.S.Smith.

M. J. Res. Developm., Vol. 4, No. 2, 205-7 (April, 1960).

For many of the thin electroplated films, only one X-ray dif-
tion line is available from a given family of lines, hence stan-
i methods for measuring crystallite size and strain cannot be
ied. Useful results however have been obtained on electro-
ed Fe—Ni films by an approximate method based on Bertaut's
ation (Abstr. 6568 of 1949). The I.B.M. 704 computer was used
ne work. An auxiliary table is given. J.Adam

539.23

4084 THE ADHESION OF VAPOUR-DEPOSITED MOLYBDENUM COATINGS. S.T.Wlodek and J.Wulff.

lektrochem. Soc., Vol. 107, No. 6, 565-8 (June, 1960).

Using a plating technique for obtaining a dense vapour-deposited
coating on a metallic base by reduction of the pentachloride with
rogen, it was found that the most important factors controlling
erence are purity of raw materials and chemical composition of
material being coated. It was also found that adherent coatings
be vapour plated on to surfaces which are free from carbon or
n constituents (e.g. Fe and Cr) that form more stable chlorides
molybdenum; the coating system must also be designed to
inate contamination of the plate by oxygen. By pre-treating
ples which contain carbon, iron, or chromium, with an electro-
e of Cu, Co, Ni or Rh (all of which form less stable chlorides
molybdenum), adherent coatings can be applied to almost any
erial stable at the plating temperature. H.H.Hodgson

539.23

14085 ANODIC OXIDE FILMS ON NIOBIUM: THICKNESS, DIELECTRIC CONSTANT, DISPERSION, REFLECTION NIMA, FORMATION FIELD STRENGTH, AND SURFACE AREA.

oung.

ad. J. Chem., Vol. 38, No. 7, 1141-7 (July, 1960).

The wavelengths of minimum specular reflectivity (at 11° inci-
ce) due to interference were determined using a spectrophoto-
er for a series of films formed on chemically polished niobium.
h a value of the refractive index n = 2.46 ± 1% at 4358 A wave-
gth by the Abeles method (reported elsewhere), the spectrophoto-
ric data give the refractive index as a function of the wavelength
$= 2.26 + 0.398/(\lambda/10^3\ A - 2.56)^{1.2}$. To analyse the spectro-
tometric results, an auxiliary measure of thickness was required
ugh with the chart given, the thickness of a film may be
ermined directly from spectrophotometric measurements alone).
ombination of measurements of the a.c. capacity and of the
rge required to form the films gives a suitable measure of
kness (in terms of ρ/ϵ, where ϵ = dielectric constant and
density) which is not dependent on a knowledge of the true surface
a. The spectrophotometric data provide a calibration of this
asure of thickness and thus give ϵ/ρ. With $\rho = 4.36$ g/cm^3
orted for the bulk amorphous oxide) this gives ϵ about 41
npared with about 27.6 for Ta_2O_5). The effective surface area
he chemically polished metal was then found to be about 7%
ater than the apparent area. At the ionic current density used
orm the films (10 mA/cm^2), the field strength in the oxide was
imated as 4.96×10^6 V/cm within a few per cent uncertainty.
ause the field to produce a given ionic current is lower than
Ta_2O_5 films, the capacity of films formed to a given voltage at
iven current density and temperature is not so much greater for
ium than for tantalum as the dielectric constants might lead one
expect. It is suggested that there may be a correlation between
ectric constant and ionic conductivity. The Nb_2O_5 films re-
stallize like Ta_2O_5 films under an applied field, but more readily.

539.23

14086 EVAPORATED FILMS OF NIOBIUM. D.Shaw and B.N.Watts.

Brit. J. appl. Phys., Vol. 11, No. 7, 304-5 (July, 1960).

Niobium layers evaporated from a tungsten filament are heavily contaminated with tungsten. If a tantalum strip is used as the evaporation source the composition of the deposit varies with time from 69%Nb—31%Ta to 50%Nb—50%Ta. Films of this nature, 0.1-0.2µ thick, can be used on uranium in reactors to prevent interaction with the aluminium used for canning. C.Hilsum

539.23

14087 EFFECTS OF OIL VAPOUR CONTAMINATION ON THE ADHESION OF ZINC SULPHIDE FILMS TO GLASS AND SILICA. L.Holland and S.K.Bateman.

Brit. J. appl. Phys., Vol. 11, No. 8, 382-5 (Aug., 1960).

An investigation has been made of the effect of adsorbed oil molecules from diffusion pump fluids on the adhesion of zinc sulphide films to glass and evaporated silica substrates. Zinc sulphide films evaporated on to fresh coatings of silica in a silicone oil diffusion pump system readily peeled in a humid atmosphere, because the silica was contaminated by chemisorbed silicone molecules; silicones were not chemisorbed by glass covered by adsorbed water. Tests were made to find the time taken to cover a substrate surface with sorbed layers of different types of pump oil and thereby destroy the zinc sulphide film adhesion. A test oil was held in a water-cooled tray in the coating vessel and the specimen exposed to the non-saturated oil vapour for different periods before zinc sulphide deposition. Silica coatings held at 50° C could be exposed to Silicone 703 for 1 min, and Silicone 704 for 4 min, before the adhesion of the superimposed zinc sulphide deposit was badly impaired. Adsorbed molecules of Apiezon "C" did not unduly affect the adhesion of zinc sulphide films. With a silica layer at 230° C the formation time for a chemisorbed film of silicones was 75 min. Raising the temperature of the silica surface reduces the period for which silicone molecules linger and orientate themselves on the substrate. When glass is heated in silicone vapours in vacuum it gradually becomes covered with chemisorbed molecules as the OH-groups are removed leaving the surface unshielded.

X-ray and Electron Microscope Examination

539.26

14088 TOMOGRAPH FOR INDUSTRIAL RADIOGRAPHY. D.Charles.

J. sci. Instrum., Vol. 37, No. 8, 257-8 (Aug., 1960).

Tomography is a radiographic technique originally developed for medical purposes, in which relative movements of X-ray tube, subject and film are controlled so that a defined section of the subject is recorded as a sharp image, superimposed on a diffuse background due to blurred images of the rest of the subject. A tomograph for industrial use has been developed, and its capabilities assessed by tests on an assembly of wire mesh gauzes. Its practical application has been demonstrated with two types of heat exchanger, on which useful detailed observations were made. Tomography is considered to be particularly effective for examination of such assemblies in which repetitive detail is masked by overlying layers.

539.26

14089 X-RAY REFLECTION STUDIES OF THE ANNEAL AND OXIDATION OF SOME THIN SOLID FILMS.

N.Wainfan and L.G.Parratt.

J. appl. Phys., Vol. 31, No. 8, 1331-7 (Aug., 1960).

The technique of the total reflection of X-rays has been applied to the study of thin films of Cu, Ni, Ge, and Se vacuum-deposited onto polished glass substrates. Starting with fresh films, "smooth" enough to exhibit pronounced X-ray interference fringes in the region just beyond the critical angle, the effects of vacuum anneal and oxidation were studied. Changes in the reflection curves are interpreted in terms of possible structural changes in the films. Reflection from layers of particles of carbon or polystyrene latex deposited onto "smooth" substrates was also studied for comparison.

539.27 : 535.8

CO-ORDINATION OF LIGHT AND ELECTRON MICROSCOPY. See Abstr. 12478

539.27

14090 PREPARATION TECHNIQUE FOR ELECTRON MICROSCOPY. K.Mühlethaler.
Schweiz. Arch. angew. Wiss. Tech., Vol. 26, No. 4, 157-62 (April, 1960). In German.

A useful and well illustrated account of the general methods of electron microscopic preparation. The technical details of metal shadowing, carbon deposition, replication, ultramicrotomy and the preparation of thin supporting films are described. R.Reed

539.27

14091 A SIMPLE HIGH RESOLUTION REPLICA METHOD FOR ELECTRON MICROSCOPY. W.Skatulla and L.Horn.
Exper. Tech. der Phys., Vol. 8, No. 1, 1-9 (1960). In German.

Two methods are described of forming a replica consisting of platinum, iridium and carbon, by evaporating a small piece of platinum—iridium (80%-20%) wire from a carbon rod in vacuo. A photoelectric method is used for continuous monitoring of the thickness of the deposited film. The replicas have high electron contrast and show very little structure. However, grain of order 30-40 A can be seen at high magnification, even though electron diffraction and dark ground imaging give no evidence of crystallization. The existence of such amorphous aggregates requires a less optimistic view to be taken of the resolving power of this type of replica method than that adopted by Bradley (Abstr. 3500 of 1958). Micrographs are reproduced of replicas of glass surfaces, of growth steps on molybdenum oxide crystals and of oxidized molybdenum foil, supporting the claim that the effective resolution of the Pt—Ir—C method is between 40 and 50 A. V.E.Cosslett

539.27

14092 PREPARATION OF REPLICAS OF SILVER BROMIDE FOR ELECTRON MICROSCOPY.
E.J.Meehan and W.H.Beattie.
J.Colloid Sci., Vol. 15, No. 2, 183-7 (April, 1960).

Light sensitive materials may change during shadowcasting when making a direct metal replica. Indirect replicas of AgBr particles sprayed on a Formvar-coated slide are made by direct evaporation of carbon or by a thin collodion film. The composite layers are detached on water, the Formvar dissolved in dichlorethanol, the AgBr in thiosulphate. Both types of replica may then be metal shadowed and give consistent results for particle size determinations. R.Reed

539.27

14093 INVESTIGATION OF FLUCTUATING [ELECTRIC] CHARGES IN INSULATING FILMS WITH ELECTRON RADIATION. H.Mahl and W.Weitsch.
Optik, Vol. 17, No. 2, 107-12 (Feb., 1960). In German.

During shadow projection of thin insulating foils by means of electrons, it is possible to observe a fluctuating granularity which does not occur with conducting foils. The speed of fluctuation increases with ray intensity. If it is assumed that the granularity caused by the deflection of the electrons resulting from local chan of charge in the foil, an estimate of the field intensities required f the observed deflections gives an order of magnitude for which fie emission occurs. In this way, it is possible to explain the effect a a consequence of localized charging in the interior of the irradiate foil. These local charges neutralize each other by field emission when a sufficiently high density of charge is reached.

539.27 : 539.2 : 53

STATIC AND DYNAMIC STUDIES OF MAGNETIZATION DISTRIBUTION IN THIN FILMS BY ELECTRON MICROSCOPY.
See Abstr. 11855

539.

14094 INVESTIGATION OF ICE CRYSTALS WITH THE ELECTRON MICROSCOPE. K.H.Schmidt.
Exper. Tech. der Phys., Vol. 8, No. 1, 9-13 (1960). In German.

The silicon monoxide replica method of Hall (Abstr. 2715 of 1950) was used to study the nature of the surface of ice formed in conditions similar to those of freeze-drying. Crystallites were visible in the ice in all conditions of preparation, and especially after thermal etching. V.E.Cossl

539.

14095 THE STRUCTURAL INVESTIGATION OF IRON AND STEEL WITH THE ELECTRON MICROSCOPE.
A.Schrader.
Schweiz. Arch. angew. Wiss. Tech., Vol. 26, No. 4, 163-70 (April, 1960). In German.

Replication methods are used to study the precipitation changes induced in austenitic and ferritic steels during prolonged stress at high temperatures. R.Re

539.

14096 THE ADVANTAGES OF AN IMAGE CONVERTER IN THE NEGATIVE ION MICROSCOPE.
R.Bernard, R.Goutte and C.Guillaud.
Optik, Vol. 17, No. 2, 113-17 (Feb., 1960). In German.

The difficulties of recording a negative ion image are overco by using an image converter consisting of an electrostatic immers lens. The negative ions are imaged on the cathode and the resultin secondary electrons are focused on the viewing screen. The converter also provides a magnification stage of ten times. R.Re

PHYSICAL CHEMISTRY

THERMOCHEMISTRY . REACTIONS

541.12

14097 QUANTUM STATISTICAL MECHANICAL THEORY OF THE RATE OF EXCHANGE CHEMICAL REACTIONS IN THE GAS PHASE. T.Yamamoto.
J. chem. Phys., Vol. 33, No. 1, 281-9 (July, 1960).

A theory of the reaction rate of simple exchange reactions in the gas phase is developed on the basis of the quantum-statistical mechanical theory of linear irreversible processes due to Kubo et al. (Abstr. 8437 of 1957; 7812 of 1959). A formal expression for the rate coefficient is found near the equilibrium point. A number of relations are derived concerning the scattering amplitudes for the collisions involved in these reactions. By making use of these reactions, the rate constant is expressed in terms of the reaction cross-sections in a way which coincides with that known from a more intuitive collisional approach. Since no ad hoc assumptions are made, the present theory can be said to provide a statistical mechanical foundation for the collision theory in the particular case discussed.

541.12 : 53

14098 ENTROPY PRODUCTION IN CHEMICAL REACTIONS. R.P.Rastogi and R.C.Srivastava.
J. chem. Phys., Vol. 33, No. 1, 79-80 (July, 1960).

The generalization of Prigogine and Glansdroff (Abstr. 1790 of 1955) which states that the rate of entropy production is negative in the nonstationary state and zero in the stationary state, is verified for reversible isomerization of ammonium thiocyanate and the isomerization of Δ^{α}-pentenoic acid involving a monomolecular triangular reaction.

541.1

14099 HETEROGENEOUS REACTIONS STUDIED BY MASS SPECTROMETRY. I. REACTION OF B_2O_3(s) WITH H_2O(g). D.J.Meschi, W.A.Chupka and J.Berkowitz.
J. chem. Phys., Vol. 33, No. 2, 530-3 (Aug., 1960).

Knudsen effusion and mass-spectrometric techniques were employed in studying the gaseous species in thermodynamic equilibrium with condensed boric oxide and water vapour in the temperature range from 1060° to 1450°K. Water vapour was introduced into a Knudsen cell containing B_2O_3, and the vapour effusing from the cell was analysed mass spectrometrically. The s $_2O^+$, HBO_2^+, $H_3BO_3^+$, and $(HBO_2)_3^+$ were observed. Of the s boron-containing species in equilibrium with the system, e present in largest amounts was found to be HBO_2. ΔH_0^0 for action

$$\tfrac{1}{2}H_2O(g) + \tfrac{1}{2}B_2O_3(s) \rightarrow HBO_2(g)$$

lculated to be 47.6 ± 2.0 kcal/mole. The data pertaining to mer $(HBO_2)_3$ are rather poor, but, in the temperature range ed, its concentration was less than 1% of that of the monomer and at the highest temperature (1450°K) was approximately to the concentration of H_3BO_3. A crude calculation of the heat nation of the trimer by means of the third law gives)≅−540 ± 10 kcal/mole.

541.12

100 HETEROGENEOUS REACTIONS STUDIED BY MASS SPECTROMETRY. II. REACTION OF $Li_2O(s)$ WITH). J.Berkowitz, D.J.Meschi and W.A.Chupka.

m. Phys., Vol. 33, No. 2, 533-40 (Aug., 1960).

he reaction of water vapour with lithium oxide was studied by s-spectrometric technique. In the temperature range 1100- K and with water vapour pressures of the order of 0.1 mm, the reaction product in the vapour phase was LiOH. Smaller nts of $Li_2(OH)_2$ and traces of $Li_3(OH)_3$ were measured. Various bria among the above species were studied with the use of ic substitution for lithium and hydrogen. The decomposition ium hydroxide was studied in the temperature range 500-600°K. tural parameters and vibrational frequencies were estimated ermodynamic functions were calculated for the LiOH and H)$_2$ molecules. The following heats of reaction (in kcal), which onsistent within experimental error, were determined:

$$Li_2O(s) + H_2O(g) \rightarrow 2LiOH(g) \qquad \Delta H_{1300}^0 = 79.0 \pm 2.0$$
$$Li_2O(s) + H_2O(g) \rightarrow Li_2(OH)_2(g) \qquad \Delta H_{1250}^0 = 15.0 \pm 2.0$$
$$Li_2(OH)_2(g) \rightarrow 2LiOH(g) \qquad \Delta H_{1300}^0 = 60.0 \pm 3.0$$
$$2LiOH(s) \rightarrow Li_2O(s) + H_2O(g) \qquad \Delta H_{500}^0 = 30.4 \pm 1.0$$
$$2LiOH(s) \rightarrow Li_2(OH)_2(g) \qquad \Delta H_{600}^0 = 45.0 \pm 3.0$$

541.12

101 COMPARISON OF n AND s AS FALL-OFF PARAMETERS IN THE SLATER AND RICE—RAMSPERGER—EL CLASSICAL THEORIES OF UNIMOLECULAR REACTION.

Schlag, B.S.Rabinovitch and F.W.Schneider.

em. Phys., Vol. 32, No. 6, 1599-601 (June, 1960).

The classical Rice—Ramsperger—Kassel integral for the unicular rate constant has been evaluated over a range of s values several values of b = 32, 36, 40 and 44. Equivalent values of of the Slater theory parameter n have been found by comparif the shape of the fall-off behaviour predicted by both theories upper region of fall-off. The equivalence diverges from the ing relation n = 2s−1 even below n = 8. The findings are dised briefly.

541.12

4102 CHARGE TRANSFER MECHANISM OF REACTION OF CONJUGATED MOLECULES.

kui, K.Morokuma, T.Yonezawa and C.Nagata.

em. Phys., Vol. 32, No. 6, 1743-7 (June, 1960).

Mathematical interrelations are found between the superdelizability and the Z value, i.e., two of the reactivity indexes njugated molecules. MO theoretical discussions on the mechaof aromatic substitution are also made.

541.12

4103 TRACER EXPERIMENTS ON THE REACTION OF UH_3 WITH AQUEOUS ACID.

garwala, J.B.Hunt and H.Taube.

hem. Phys., Vol. 32, No. 5, 1567-8 (May, 1960).

The ratio $H_2 : HD : D_2$ in the gas formed during the reaction of with an 11 M solution of DCl in D_2O, shows that an oxide is for on the hydride surface. This oxide prevents the direct attack)$^+$ on UH_3 and the rate of reaction is low. No oxide forms if a solution is used and the rate of reaction is much higher. There o evidence for the formation of a film of atomic hydrogen.

A.Avraam

541.12

14104 DIFFUSION THEORY OF CHAIN REACTIONS PROCEEDING FROM DIFFERENT ACTIVE CENTRES.

Y.Sayasov and S.Sayasov.

Ann. Phys. (Leipzig), Vol. 6, No. 1-2, 1-14 (1960). In German.

The general solution of a system of kinetic diffusion equations is given which is valid for chemical chain reactions involving different active centres. Therein, the general boundary conditions are considered which relate to the capture of the active centres at the walls of the reaction volume. Application of this rigorous mathematical method to the chain oxidation of hydrogen shows that the usually-used Semenov method for the integration of the kinetic equations [cf. Acta Physiocochimica URSS, Vol. 18, 93, 101 and 443 (1943)] can be invalid in many cases.

H.H.Hodgson

541.12

14105 DISCUSSION OF CRITERIA FOR THE IN SITU COMBUSTION OF CRUDE OIL. S.E.Szasz.

J. appl. Phys., Vol. 31, No. 6, 1122-3 (June, 1960).

Detailed criticism of work by Cooperman (Abstr. 12849 of 1959), on the grounds that the assumptions in it are not justified, and in particular, that the heat of combustion is not negligible and that the system cannot be in a steady state. See following abstracts.

J.Hawgood

541.12

14106 REMARKS ON SOME CRITERIA FOR THE IN SITU COMBUSTION OF CRUDE OIL.

H.R.Bailey and B.K.Larkin.

J. appl. Phys., Vol. 31, No. 6, 1123-4 (June, 1960).

Criticism of the work of Cooperman (Abstr. 12849 of 1959), mainly on the grounds of its lack of agreement with experimental data. See following abstract.

J.Hawgood

541.12

14107 REPLY TO THE LETTERS OF SZASZ, AND BAILEY AND LARKIN. P.Cooperman.

J. appl. Phys., Vol. 31, No. 6, 1124 (June, 1960).

The criticisms of the two preceding abstracts are said to be invalid, either because the experiments quoted were inaccurate or were done under radically different conditions to those originally considered, or because of misunderstanding.

J.Hawgood

541.12

14108 THE FORMATION OF A DETONATION WAVE DURING THE COMBUSTION OF A GAS IN PIPES.

G.D.Salamandra, T.V.Bazhenova and I.M.Naboko.

Zh. tekh. Fiz., Vol. 29, No. 11, 1354-9 (Nov., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 11, 1244-9 (May, 1960).

Time resolved schlieren records and high speed photographs of the transition from steady burning to detonation are obtained. The shape of the flame front is recorded at various stages during the transition and it is shown that shock waves produced in the flame front interact with it and cause detonation.

E.R.Wooding

541.12 : 532.5

14109 ANALYSIS OF STEADY-STATE SUPPORTED ONE-DIMENSIONAL DETONATIONS AND SHOCKS.

W.W.Wood and Z.W.Salsburg.

Phys. of Fluids, Vol. 3, No. 4, 549-66 (July-Aug, 1960).

Consideration is given to the possible steady one-dimensional flows which can occur in a medium in which an arbitrary number of chemical reactions proceed behind an initiating shock, and the stability of solutions to the chemical rate equations is investigated. The theoretical apparatus is that of irreversible thermodynamics and nonlinear mechanics, with neglect of transport processes. Most of the discussion is concerned with detonations, but the analysis applies to all such reacting systems. For detonations, it is shown that under suitable conditions on the rate functions, there are stable solutions resulting in an equilibrium final state for detonation velocities equal to or greater than the "equilibrium Chapman-Jouguet (C-J)" value corresponding to tangency of the Rayleigh line and the equilibrium Hugoniot. The final state in such a flow is the high-pressure intersection of the Rayliegh line and the equilibrium Hugoniot. It is suggested that these solutions correspond to piston-supported dentonations after decay of initiation transients, and further that the equilibrium C-J detonation is stable with respect to removal of the piston support at sufficiently late times. The "normal frozen C-J condition," corresponding to attainment of chemical equilibrium at a point where the flow velocity is sonic with respect to the "frozen" or high frequency sound speed, is shown to result in an unstable solution. Solutions corresponding to "pathological detonations," in which the region of steady flow terminates at a point of incomplete reaction, are identified, but the conditions necessary or sufficient for their realization have not been obtained, nor has the nature of the subsequent time-dependent flow been elucidated. Thus their physical significance remains somewhat doubtful.

541.12 : 534.22

14110 A METHOD OF STUDYING THE STATE OF THE PRODUCTS OF AN EXPLOSION BY MEASURING THE PARAMETERS OF SHOCK WAVES. O.A.Tsukhanova.

Zh. tekh. Fiz., Vol. 30, No. 2, 242-7 (Feb., 1960). In Russian.

Describes the measurement of the velocity of shock waves, and of the pressure p and the gas flow velocity in front of and behind the shock waves, travelling through the products of an explosion of a gaseous mixture in a tube. Shows how it is possible from these measurements to determine the density ρ and the ratio $\frac{p}{\rho} = \frac{RT}{\mu}$ (μ-molecular weight) along the tube as functions of time, and to reach conclusions about the degree of completion of the chemical process. The heat loss to the walls of the tube is also calculated. After explosion of the mixture $2O_2 + H$ it was found that equilibrium is established within about 10^{-3} sec. J.Jarzynski

541.12

14111 MECHANISM OF THE INTERMOLECULAR EXCHANGE OF ENERGY IN THE DISSOCIATION OF DIATOMIC GAS.

E.E.Nikitin.

Dokl. Akad. Nauk SSSR, Vol. 132, No. 2, 395-8 (May 11, 1960). In Russian.

Recent experimental results obtained in the investigations of reactions of thermal dissociation of diatomic molecules in shock waves show that, behind the front of the shock wave, this dissociation takes place sometimes much faster in pure diatomic gas than in the atmosphere of an inert monatomic gas. It is demonstrated that this behaviour is easily explained on the basis of previously developed ideas relating to the mechanism of thermal dissociation [Nikitin, Dokl. Akad. Nauk SSSR, Vol. 119, No. 3, 526 (March 21, 1958); Nikitin and Sokolov (Abstr. 3298 of 1960)]. F.Lachman

541.12

14112 NEW DATA ON THE INFLUENCE OF A RADIOACTIVE SOLID PHASE ON HETEROGENEOUS PROCESSES OF ISÔTOPIC EXCHANGE. I.E.Mikhailenko and V.I.Spitsȳn.

Dokl. Akad. Nauk. SSSR, Vol. 131, No. 1, 129-32 (March 1, 1960). In Russian.

In the $K_2SO_4-SO_3$ system at 840°C it is shown that the degree of isotopic exchange varies markedly with specific activity of the K_2SO_4 (~12% at 1.7×10^{-2} MCu/g to ~85% at 131 MCu/g). The system $Na_2SO_4-SO_3$ was studied over the temperature range 700-840°C and $K_2SO_4-SO_2$ over the range 600-840°C. H.C.Cole

541.12

14113 SIMPLIFIED METHOD FOR THE MEASUREMENT OF SOME ISOTOPE EFFECTS IN CHEMICAL KINETICS BY MEANS OF RADIOISOTOPES. V.Santoro.

Nuovo Cimento, Vol. 15, No. 6, 865-72 (March 16, 1960). In Italian.

Examines the possibility of precise measurements of isotopic effects on the rate constants of bimolecular thermal equilibrium reactions of the general kind $A_2 + B_2 \rightarrow 2\,AB$ when one of the isotopes involved is radioactive. The impossibility of the measurement by means of carrier-free isotopes is evaluated through an approximate expression. A method is proposed whose essential feature consists of carrying out the reaction of the radioactive species $AA^* + B_2 \rightarrow AB + A^*B$, in the presence of relatively large amounts of A_2, B_2 and AB in chemical equilibrium. If the measurement is performed as suggested, the required velocity constant is given by an expression which on examination from the standpoint of errors shows that the magnification factors of the experimental errors on the measured quantities are sufficiently small to allow a significant comparison between experimental and theoretical results.

541.12

14114 ISOTOPE EFFECT IN THE HYDROGEN ATOM—FORMALDEHYDE REACTION.

J.R̂.McNesby, M.D.Scheer and R.Klein.

J. chem. Phys., Vol. 32, No. 6, 1814-17 (June, 1960).

The isotope effect in the hydrogen abstraction from formaldehyde by hydrogen atoms has been measured. The activation en difference derived from relative rate measurements of the pair o reactions

$$H + H_2CO \rightarrow H_2 + HCO$$
$$H + D_2CO \rightarrow HD + DCO$$

is $E_2 - E_1 = 1.0$ kcal. The value for the corresponding pair

$$D + H_2CO \rightarrow HD + HCO$$
$$D + D_2CO \rightarrow D_2 + DCO$$

$E_4 - E_3 = 0.9$ kcal, is calculated from (2), (1), and the variation of the hydrogen—deuterium equilibrium constant with temperature. Application of the Bigeleisen theory of the isotope effect to these reactions suggests a loosely bound activated complex.

541.

14115 NOTE ON SECONDARY ISOTOPE EFFECTS IN REACTION RATES. M.Wolfsberg.

J. chem. Phys., Vol. 33, No. 1, 2-6 (July, 1960).

It is shown that secondary kinetic isotope effects, for all isotopes with the possible exception of hydrogen isotopes, are expected to be small unless the force constants involving the isotopically substituted positions are considerably different in the transition state from those in the reactant. Cases involving secon ary hydrogen isotope effects are investigated in detail for certain model reactions. It is concluded that hydrogen isotope effects do not constitute an exception to the above rule.

541.

14116 ISOTOPE EFFECTS ON REACTION RATES AND THE REACTION COORDINATE. M.Wolfsberg.

J. chem. Phys., Vol. 33, No. 1, 21-2 (July, 1960).

The high temperature limit of the reaction rate isotope effect is discussed. The Slater approach is compared in this respect to the transition state theory approach. There is no essential disagreement between the two approaches. The Slater assumption with respect to this limit for simple bond rupture represents a special case, however, and is not necessarily correct.

541.

14117 PROTON-TRANSFER STUDIES BY NUCLEAR MAGNETIC RESONANCE. I. DIFFUSION CONTROL IN TE REACTION OF AMMONIUM ION IN AQUEOUS ACID.

M.T.Emerson, E.Grunwald and R.A.Kromhout.

J. chem. Phys., Vol. 33, No. 2, 547-55 (Aug., 1960).

Rate constants were determined by precise nuclear-magnetic resonance techniques for the reactions:

$$NH_4^+ + H_2O \xrightarrow{k_4} NH_3 + H_3O^+;\ NH_3 + H_3O^+ \xrightarrow{k_{-4}} NH_4^+ + H_2O;$$

and

$$\underline{N}H_4^+ + NH_3 \xrightarrow{k_6} \underline{N}H_3 + NH_4^+$$

in aqueous acid at 25°C. For 0.25-3.00 M NH_4Cl, k_{-4} and k_6 were 4.3×10^{10} $sec^{-1}\,M^{-1}$ and 1.17×10^9 $sec^{-1}\,M^{-1}$ respectively, indepe dent of NH_4Cl concentration. Both rate constants increase on addi of KCl. The rate constant, k_4, was 24.6 sec^{-1} at zero ionic streng and decreased sharply with NH_4Cl concentration. The values of K, needed in the kinetic analysis were measured also. The reaction NH_4^+ with H_2O was investigated also in 50-60 wt % $H_2SO_4-H_2O$ mixtures, where the half-life for isotopic exchange was between two and 20 min. The data allowed estimation of the rate constant $(1/\tau_D + 1/\tau_R)$ for the rupture of the $H_3N \cdots HOH$ hydrogen bond, by diffusion (D) or rotation (R). The value obtained was 51×10^{10} sec Using Einstein's theory of Brownian motion, the value of $1/\tau_D$ was estimated to be 34×10^{10} sec^{-1}, leaving 17×10^{10} sec^{-1} for $1/\tau_R$, which 12×10^{10} and 5×10^{10} sec^{-1} are the contributions due to the rotation of H_2O and NH_3, respectively. The probability that NH_3 rotates during an encounter is therefore fairly small. The order magnitude of k_{-4} and k_6 suggests that these reactions are diffusion controlled. Upon applying the Debye—Smoluchowski theory to calc ate the frequency of encounters, it was found that k_{-4} is consistent with reaction occurring whenever H_3O^+ and NH_3 are next-nearest neighbours. The steric factor for this reaction appears to be unit Since the data in strong acid suggest that rotation of a molecule during an encounter is improbable, it is concluded that the reacta are oriented during their approach so that the unshared electrons the NH_3 face an acidic hydrogen. To interpret k_6, a mechanism is assumed in which NH_3 and NH_4^+ become next-nearest neighbours b

diffusion; the jump to a nearest-neighbour site then requires
ewhat higher activation energy than simple diffusion because
ust dsiplace a tightly bonded water molecule. The reaction
ate constant k_4 is activation controlled. The negative salt
on k_4 suggests diffusion of charge in the transition state.

541.12

118 PROTON-TRANSFER STUDIES BY NUCLEAR MAGNETIC RESONANCE. II. RATE CONSTANTS AND ANISM FOR THE REACTION $CH_3NH_3^+ + OH_2 + NH_2CH_3$ IN OUS ACID.

nwald, P.J.Karabatsos, R.A Kromhout and E.L.Purlee.
m. Phys., Vol. 33, No. 2, 556-63 (Aug., 1960).

ate constants were measured by precise nuclear-magnetic-
ance techniques for the reactions

$$CH_3\underline{N}H_3^+ + NH_2CH_3 \xrightarrow{k_6} CH_3\underline{N}H_2 + H\overset{+}{N}H_2CH_3,$$

$$CH_3\underline{N}\overset{+}{H}_3 + OH_2 + NH_2CH_3 \xrightarrow{k_7} CH_3\underline{N}H_2 + HOH + H\overset{+}{N}H_2CH_3,$$

eous acid at 25°. The ratio k_6/k_7 remained virtually constant
en 1.7 and 8.1 M concentration of CH_3NH_3Cl. The rate constants
inversely proportional to the viscosity of the solution, and
extrapolated on this basis to infinite dilution to yield the values
.0 × 10^8 sec^{-1} M^{-1} and $k_7^0 = 5.3 \times 10^8$ sec^{-1} M^{-1} at 25°. Acid
iation constants, densities, and viscosities for 1.7 to 9 M
ons of CH_3NH_3Cl in water were measured also. Measurements
water activity of these solutions showed that the mean ionic
activity coefficients of CH_3NH_3Cl were virtually constant over
tire range. The magnitude of k_7, as well as the constancy of
indicated that the most probable rate-determining step for
action with rate constant k_7 is proton transfer from a water
ule in the solvation shell of CH_3NH_2, to a molecule of CH_3NH_2,
duce the triple ion,

$$CH_3N\overset{+}{H}_3 \cdot OH \cdot HNH_2{}^+CH_3.$$

ELECTROCHEMISTRY

541.13

119 THE FARADAIC ADMITTANCE OF ELECTROCHEMICAL PROCESSES. I. APPARATUS SUITABLE PHASE ANGLE MEASUREMENT.

H.H.Bauer and P.J.Elving.
ner. Chem. Soc., Vol. 82, No. 9, 2091-4 (May 5, 1960).

An improved apparatus for measuring the effects of a small
rposed sinusoidal alternating potential on the behaviour of
rochemical systems is described. From measurements of the
s resistance, the capacity of the electrical double layer, and
ross alternating potential and current and phase angle, the
acteristic properties of the faradaic process including the phase
can be calculated readily. The theoretical basis for the
rimental procedure is critically discussed; the procedure itself
ven in detail.

541.13

4120 THE FARADAIC ADMITTANCE OF ELECTROCHEMICAL PROCESSES. II. EXPERIMENTAL TEST HE THEORETICAL EQUATIONS.

Bauer, D.L.Smith and P.J.Elving.
mer. Chem. Soc., Vol. 82, No. 9, 2094-8 (May 5, 1960).

This study is an evaluation of the two equations obtained to
ribe the behaviour of a simple oxidation-reduction reaction under
nfluence of a small superposed alternating potential. The
nium system, which is the most thoroughly studied system, was
stigated under a variety of conditions. While either equation
be applicable to results for a particular system involving fixed
entration of depolarizer and background medium over a narrow
uency range, neither equation is of general applicability, e.g.
ner describes satisfactorily the observed variation of the phase
e and hence of the heterogeneous rate constant with frequency
depolatizer concentration. The difficulties would seem to be
ciated with the use of invalid postulates in setting up the theories
h led to the equations. It is suggested that a more rigorous
nematical treatment of the problem would involve consideration of
e rectifying properties of the system.

541.13

14121 INVESTIGATIONS IN THE STATISTICAL-MECHANICAL THEORY OF STRONG ELECTROLYTES. I. FUNDAMENTAL STATISTICAL-MECHANICAL EQUATIONS.

G.Kelbg.
Z. phys. Chem. (Leipzig), Vol. 214, No. 1-2, 8-25 (1960). In German.

In an electrolytic solution the ions are regarded as a mixture of gases existing in a continuous medium (the solvent) of macroscopic dielectric constant, D, and viscosity, η. Possible interactions are considered and the interionic potential, $u_{ij}(r)$, regarded as being expressible by

$$\left(\frac{e_ie_j}{Dr}\,u(r) + \varphi\,(r)\right),$$

where u(r) is a non-singular function by means of which deviations from Coulomb's law at small distances as a result of structure changes of the solvent or alteration of D can be taken into account. $\varphi(r)$ takes account of the short-range forces. With the help of some approximations and of Fourier transformations, the integral equations are solved and explicit functions derived for radial distribution in electrolytes. W.Good

541.13

14122 INVESTIGATIONS IN THE STATISTICAL-MECHANICAL THEORY OF STRONG ELECTROLYTES. II. RIGID SPHERES WITH POINT CHARGES AT THE CENTRES.

G.Kelbg.
Z. phys. Chem. (Leipzig), Vol. 214, No. 1-2, 26-39 (1960). In German

The theory developed in Pt I is applied to the derivation of an expression for the osmotic coefficient (g) of a system of rigid spheres with point charges at their centres. The expression is compared with that given by the cluster-integral method, and a plot of (1-g) against $\sqrt{c}$ (c in mole/litre) shown for a uni-univalent electrolyte in water at 0°C, the radius of the spheres being 3 A.

W.Good

541.13

14123 FLOW ADAPTATION OF THE ISOTOPIC DILUTION METHOD FOR THE STUDY OF IONIC HYDRATION.

H.W.Baldwin and H.Taube.
J. chem. Phys., Vol. 33, No. 1, 206-10 (July, 1960).

A method is described for rapid mixing and sampling in the application of the isotopic dilution technique to the study of ionic hydration. The behaviour of solutions of various salts has been compared with that of solutions containing a hydrated cation of known formula, namely $Cr(H_2O)_6{}^{3+}$ (Abstr. 5849 of 1951). The holdback of water per ion of Al^{3+} is the same (within 0.4 molecules of H_2O) as that of Cr^{3+}, and $t_{1/2}$ for the exchange of $Al(H_2O)_6{}^{3+}$ with H_2O is >0.02 sec. at 25°. $t_{1/2}$ for the exchange of water between Ni^{2+} (aq) or Fe^{3+} (aq) and solvent is <0.02 sec.

541.13

14124 THE POTENTIAL OF THE SEMICONDUCTOR–SOLUTION INTERFACE IN THE ABSENCE OF NET CURRENT FLOW: GERMANIUM.

B.Lovreček and J.O'M.Bockris.
J. phys. Chem., Vol. 63, No. 9, 1368-73 (Sept., 1959).

The potential at the interface between n- and p-type Ge electrodes of crystal orientations 110 and 111 was measured in highly pure aqueous solutions of GeO_2, of pH 0-14. The potential was affected by stirring and by impurities in the low pH range. Over certain ranges of pH, $\delta e/\delta pH \cong 2.303\ RT/F$. GeO_2 and H_2 concentrations have no definite effect. O_2 tends to increase the range in which $\delta e/\delta pH = 2.303\,RT/F$. No essential difference was observed between n- and p-type samples, or those of different crystal orientation. Calculation of the mixed potential indicates only a small deviation from a thermo-dynamically reversible potential. Calculation of potential–pH relations for various reactions involving Ge suggests a significant error in the previously accepted values. The observed results correspond to those of the reaction $Ge + H_2O \rightleftharpoons GeO + 2H^+ + 2e_0{}^-$, the germanous oxide appearing in two forms, depending on pH and age of the electrode. The recorded phenomena are consistent with this mechanism.

541.13 : 539.2 : 537.311

ELECTRODEPOSITION OF Cu ON Ge P–N JUNCTION FOR DELINEATION. See Abstr. 13593

541.13 : 539.2 : 537.311

THE CHARGE AND POTENTIAL DISTRIBUTIONS AT THE ZINC OXIDE ELECTRODE. See Abstr. 13618

541.13 : 539.2

CATIONIC MOVEMENT AND COLOUR CENTRE FORMATION DURING THE ELECTROLYSIS OF QUARTZ PLATES PERPENDICULAR TO THE C-AXIS. See Abstr. 13551

541.13

14125 TRACER FOLLOWS LEVELER IN ELECTROPLATING BATH. S.E.Beacom and B.J.Riley.
Nucleonics, Vol. 18, No. 5, 82-4 (May, 1960).

S^{35} labelled sodium allyl sulphonate was used in a nickel plating bath and the distribution of its deposition on a ridged surface determined. Results show that S^{35} is deposited preferentially on the peaks. This supports the theory that the leveller diverts the metal from high spots into the valleys, thus producing a bright surface. R.D.Smith

541.13

14126 FUEL CELLS.
D.L.Douglas and H.A.Liebhafsky.
Phys. Today, Vol. 13, No. 6, 26-30 (June, 1960).

Article based on lecture to the American Physical Society on the history, operation, and applications of fuel cells.

PHOTOCHEMISTRY RADIATION CHEMISTRY

541.14

14127 PHOTO-OXIDATION OF BIACETYL.
G.B.Porter.
J. chem. Phys., Vol. 32, No. 5, 1587-8 (May, 1960).

The oxidation has been studied at 4358 A at which there is no photodissociation into radicals in the absence of oxygen. There being no evidence for a chain reaction (at 30° C) the relatively high quantum yields of products indicate that triplet molecules are formed with almost unit efficiency. W.Good

541.14

14128 PHOTOLYSIS OF AMMONIA IN A SOLID MATRIX AT LOW TEMPERATURES. O.Schnepp and K.Dressler.
J. chem. Phys., Vol. 32, No. 6, 1682-6 (June, 1960).

Solid deposits of argon containing 0.3 mole % ammonia were irradiated at 4.2° K with light of wavelengths shorter than 2000 A. The emission of a hydrogen discharge with a LiF window and of a thin-walled quartz mercury arc were used, The production of the unstable species NH and NH_2 was observed by means of electronic absorption spectroscopy. Experiments using filters led to the conclusion that NH is produced by irradiation with light of wavelengths shorter than 1550 A. NH_2 is produced by radiation above 1700 A and below 1550 A with comparable quantum efficiency. Warmup experiments show that NH_2 disappears close to 20° K whereas NH is stable up to at least 36° K. Photolysis at 20° K is approximately five times less efficient than at 4.2° K. On certain assumptions a molar absorption coefficient of 40 000 is estimated for both NH and NH_2 and the f values of the observed transitions of these molecules are estimated to be of the order of 10^{-3}.

541.14

14129 PRIMARY PROCESSES IN THE GASEOUS PHOTOLYSIS OF POLYATOMIC MOLECULES. I. BIACETYL.
J.T.Dubois.
J. chem. Phys., Vol. 33, No. 1, 229-31 (July, 1960).

The application of photochemical information to the characterization of primary processes is discussed; the selection of proper experimental conditions is of crucial importance in order to avoid ambiguous or misleading interpretations of such data. As an example, the existing data on the photolysis of biacetyl in the range λ 4358-3660 A is analysed. The treatment indicates the presence of a single process with an activation energy E = 13 300 E = 13 300 cal/mole and a frequency factor $\nu = 1.5 \times 10^{13}$ sec^{-1}.

541.14 : 539.2 : 535.37

PHOTOLYSIS OF DIAZOMETHANE IN A SOLID MATRIX: CHEMILUMINESCENCE OF ETHYLENE. See Abstr. 13723

541.14

14130 PHOTOCHEMICAL EVIDENCE FOR TRIPLET STATE QUENCHING BY PARAMAGNETIC SPECIES.
W.M.Moore, G.S.Hammond and R.P.Foss.
J. chem. Phys., Vol. 32, No. 5, 1594-5 (May, 1960).

Is found in the decrease of quantum yield in the photoreduction of benzophenone by toluene or cumene brought about by the presence of trace amounts (10^{-4} M) of metal (ferric iron, samarium, and erbium) chelate compounds in which the ligand is the dipivaloylmethide ion. The corresponding aluminium chelate has no measu able effect. Data are shown for the photoreduction of benzopheno by benzohydrol in benzene solution with no additive, with the iron chelate, and with oxygen present. W.Go

541

14131 THE EFFECT OF HIGH-INTENSITY ULTRASOUNDS VERY VISCOUS [MINERAL] OILS. P.Greguss.
Acustica, Vol. 7, No. 5, 264-6 (1957). In French.

The composition of the oil is changed when irradiated with 30 W/cm^2 at a frequency of 1 Mc/s. It is also noted that the presence of oxygen and hydrogen inhibits such sono-chemical reactions.

541

14132 REACTIONS INITIATED BY THE β DECAY OF TRITI III. THE TRITIUM–CYCLOPROPANE SYSTEM.
P. L.Gant and K.Yang.
J. chem. Phys., Vol. 32. No. 6, 1751-63 (June, 1960).

For Pt II, see Abstr. 3321 of 1960. The β-decay of tritium in the gaseous tritium-cyclopropane system initiates reactions fo ming various tritiated compounds. Identified products are cyclopropane, propane, propylene, isobutane, ethane, ethylene, and acetylene. Dependence of the labelling yields on T_2 concentration clearly showed that energetic electrons as well as the decay species $(He^3T)^+$ initiated the labelling processes. Ionic and/or hot-atom reactions are assumed to occur to explain the effects of nitric oxide and temperature on the labelling yields.

541

14133 RADIOLYSIS OF METHANOL BY RECOILS FROM TH $B^{10}(n,\alpha)Li^7$ REACTION.
Sang Up Choi, N.N.Lichtin and J.J.Rush.
J. Amer. Chem. Soc., Vol. 82, No. 12, 3225 (June 20, 1960).

541

14134 RADIOLYSIS OF CYCLOHEXANE. I. PURE LIQUID CYCLOHEXANE AND CYCLOHEXANE–BENZENE SOLUTIONS. G.R.Freeman.
J. chem. Phys., Vol. 33, No. 1, 71-8 (July, 1960).

The radiation chemistry of pure liquid cyclohexane and of cyc hexane–benzene solutions was investigated. The cyclohexane rad lysis system appears to contain at least two distinct activated spe one of which (c-C_6H_{12}'') is subject to "protection" by benzene whil the other (c-C_6H_{12}') is not. The approximate yields of these two species, determined by kinetic analysis, are G(c-C_6H_{12}'') = 3.0 ± 0 and G(c-C_6H_{12}') = 2.4 ∓ 0.4. In addition to the usual products, cyc hexylcyclohexadiene and dicyclohexadiene were measured in the cyclohexane–benzene system. A mechanism is proposed to expla the formation of the major products and the variation of their yiel with benzene concentration. A limiting-case calculation for the upper limit of the rate constant for energy transfer between molecules in the present system (10^{13}-10^{14} litre mole/sec) agrees well with a similar calculation in the literature, for energy transfer in organic solution scintillators. Another limiting-case calculation shows that the rate constant for energy transfer might also be considerably smaller than the above value.

54

14135 HETEROGENEOUS NATURE OF REACTION IN RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF ACRYLAMIDE. G.Alder and W.Reams.
J. chem. Phys., Vol. 32, No. 6, 1698-1700 (June, 1960).

It has been suggested that the radiation-induced solid-state polymerization of acrylamide is a heterogeneous reaction, that is. it goes by a two-phase mechanism (Adler, Abstr. 13764 of 1959). According to this concept, the reaction procedes at definite sites within the crystal. After the first reaction steps, it forms regions of pure or nearly pure polymer imbedded in pure monomer. Furth reaction would take place at the interface between the two. The polymer and monomer regions would remain segregated until the crystal is completely polymerized. It has been shown previously that the reaction can take place without the crystal breaking up. The alternative to this scheme seems to be that the reaction takes place within the crystal lattice and is directed by it. This require a more homogeneous reaction mechanism. It seems feasible, in principle to distinguish between the two mechanisms by X-ray diffraction. A single crystal technique that allows one to look at all the reflections simultaneously appeared to be most promising. It was therefore decided to run a series of rotation diagrams on a crystal in various stages of polymerization.

541.15 : 532.7

136 PRIMARY PROCESSES IN THE ACTION OF IONIZING RADIATIONS ON WATER: FORMATION AND TIVITY OF SELF-TRAPPED ELECTRONS ("POLARONS").

ss.

e (London), Vol. 186, 751-2 (June 4, 1960).

he possible behaviour of polarons in irradiated water and in discussed. The polaron is an electron ejected into the water it polarizes the surrounding medium and in turn keeps that ization stationary. The radius of the polaron in water can be to be of the order of 10 A. It can be pictured as an electron ging collectively to a number of water molecules and relatively . It will. however, react with other suitable centres in the , e.g. $(H_2O)^-$ with $(H_2O)^+$ to form water, or with H^+ to give $_2O$. If solutes are present to act as acceptors, they will ete for polarons. The existence of polarons can also account e thermoluminescence of irradiated ice. C.B.Allsopp

541.15

137 ATOMIC AND MOLECULAR HYDROGEN YIELDS FROM IRRADIATED ACIDS. R.Livingston and A.J.Weinberger.

em. Phys., Vol. 33, No. 2, 499-508 (Aug., 1960).

The paramagnetic-resonance method was used to measure the s of atomic hydrogen from many concentrations of aqueous uric, phosphoric, and perchloric acids at 77°K after gamma-rradiation. The yields of molecular hydrogen (and oxygen) also measured after similarly irradiated acids were warmed he gases collected. The correspondence between atom and cule yields is discussed. In sulphuric and phosphoric acids tom and molecule yields depend upon whether the acid is a sy or crystalline solid at the time of irradiation. Prolonged liation of 0.129 mole-faction sulphuric acid (glassy) gives a ration concentration of 3.4×10^{18} hydrogen atoms per gram. corresponding number for 0.125 mole-fraction perchloric acid 9×10^{19}. The scavenging effects of nitric acid and hydrogen xide on the atomic and molecular hydrogen yields for 0.129 -fraction sulphuric acid were measured and are discussed. The esponding effect of nitric acid on the atom yield from perchloric is presented.

541.15

4138 CHEMICAL PROTECTION FROM RADIATION EFFECTS.

D.R.Kalkwarf.

eonics, Vol. 18, No. 5, 76-81, 130-1 (May, 1960).

Additions of chemicals can reduce radiation damage by (a) a ent molecule absorbing energy from excited molecules of the tance protected or (b) combining with decomposition products preventing further decomposition or (c) forming complexes that less sensitive to radiation than the original molecules. Examples ese three effects are given. Possible applications in decreasing effects of ionizing radiations on living systems are discussed, example, 2-mercaptoethylguanidine has been shown to double lethal dose of radiation for mice. Industrial uses include ection of the lubrication properties of mineral oils by the tion of aromatic compounds such as 1-methyl-napthalene, vention of cross-linking in plastics and prevention of darkening lass. A very extensive bibliography is included. R.D.Smith

DISPERSIONS . COLLOIDS ADSORPTION

541.18

14139 SINGLE TUBE SEDIMENTATION APPARATUS FOR THE MEASUREMENT OF PARTICLE SIZE DISTRIBUTION.

obak and D.J.Loveridge.

sci. Instrum., Vol. 37, No. 8, 266-9 (Aug., 1960).

The equipment described is of the "liquid column with sediment raction" type which enables dilute suspensions, 0.05% solids con-ntration by volume, to be used. Thus the sedimenting conditions roximate to those required for unhindered settling of the particles. e apparatus is simple in design and does not require any specialized lls in its operation; one operator can easily control two sizings. o similar sedimentation tubes have been shown to be devoid of ividual characteristics and to be capable of giving reproducible sults. The results compared well with those obtained in other oratories using different sedimentation methods.

541.18

14140 APPLICATION OF PHOTOELECTRIC DENSITOMETRY TO THE ASSESSMENT OF RESPIRABLE DUST SAMPLES.

A.R.Bugden, R.J.Hamilton and G.H.S.Jones.

Brit. J. appl. Phys., Vol. 11, No. 8, 371-7 (Aug., 1960).

A technique has been developed for rapid assessment of the samples of respirable mine dust obtained with the long-running thermal precipitator (NCB/MRE dust sampler type 101). The size segregation of particles in these dust samples enables the optical density of a thin strip across the deposit to be converted to the number of particles in that strip, the relationship being a function of mean particle size. The addition of a spacially shaped weighting mask in the light beam enables a single measurement of the optical density of the whole deposit to be converted to the total number of particles, independently of the size distribution of the dust. A densitometer has been devised and laboratory and field trials have established appropriate conversion factors from optical density to number of particles. The loss of light caused by the sample is measured over a small angle in order to reduce the difference between coal and the more transparent rock particles. For routine mine samples, which consists in general of mixed coal and rock, use of mean conversion factors is recommended. Operation of the apparatus is simple and rapid, with accuracy and consistency comparable with microscope counting, and it is believed that a high proportion of the routine dust samples can be evaluated in this way. Further advantages of the technique are that it can be adapted, in conjunction with incineration to the compositional analysis of dust samples and, by using appropriate conversion factors or weighting masks, to the measurement of the mass of dust in the samples.

541.18

14141 METHOD FOR CALCULATING AVERAGE MOLECULAR WEIGHTS AND MOLECULAR WEIGHT DISTRIBUTIONS OF POLYMERIC MATERIALS FROM SEDIMENTATION EQUILIBRIUM EXPERIMENTS.

H.Fujita.

J. chem. Phys., Vol. 32, No. 6, 1739-42 (June, 1960).

A method is proposed for the determination of average molecular weights and molecular weight distributions of polymeric materials from sedimentation equilibrium experiments in theta solvents. The data required are the refractive index gradients at the centre of the ultracentrifuge cell as a function of a parameter $\lambda = (1 - \bar{v}\rho_0) \times (r_2^2 - r_1^2)\omega^2/2RT$; here $\bar{v}$ is the partial specific valume of the polymer solute in the given solvent, ρ_0 is the density of the solvent, ω is the rotor speed, r_1 and r_2 are the radial distances from the rotor axis to the meniscus and the bottom of the cell, respectively, T is the absolute temperature, and R is the gas constant. The most important feature of the proposed method is that it allows calculation of the number-average molecular weight. The desired distribution of molecular weights of a given sample can be obtained by solving an integral equation of the Fredholm type.

541.18

14142 THE TORSIOMETER — AN INSTRUMENT FOR THE STUDY OF GELS CONSIDERED AS ELASTIC SOLIDS.

W.A.Southorn.

J. sci. Instrum., Vol. 37, No. 8, 292-6 (Aug., 1960).

Studies changes in development of structure in the weak hydrogels produced when natural rubber latex from Hevea braziliensis is coagulated. The instrument records on a chart the progressive changes in torque required to give a fixed small value of deformation in an annular sample. The machine can be used for gel systems other than rubber, and may therefore have applications in other fields. Results may be expressed directly as a modulus of rigidity for materials with properties approximating to those of an elastic solid. For visco-elastic materials the modulus is a complex function including viscosity components. The range of sensitivity of the instrument is from 1 to 100 000 dyn/cm².

541.18

14143 THE UTILIZATION OF A COLD TRAP TO STABILIZE SUSPENSIONS OF UO_2 IN NaK.

P.R.Huebotter and W.R.Seitz.

Nuclear Sci. Engng, Vol. 5, No. 1, 11-14 (Jan., 1959).

Loop studies have been made on UO_2—NaK slurries at temperatures up to 1050° F. The maximum UO_2 concentration was 4.15 volume per cent or 35 weight per cent at room temperature. A flow rate of 5.4 ft/sec was required to suspend all of the UO_2 in this slurry at 1050° F. Lesser flow rates were required at lower temperatures. It was discovered that by installing a static cold trap, which was jointed vertically upward from the lower horizontal leg of the loop, the slurry become more stable at the higher temperatures. The function of the cold trap is thought to be that of removing, from the circulating slurry, oxygen contamination which may have rendered previous attempts to maintain a stable suspension above 932° F unsuccessful. In the present study, the UO_2 could be easily resuspended after prolonged settling.

541.18

14144 CRYSTALLIZATION OF ALUMINIUM AEROSOLS. M.Ya.Gen, I.V.Eremina and Yu.I.Petrov.

Zh. tekh. Fiz., Vol. 29, No. 11, 1407-11 (Nov., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 11, 1296-9 (May, 1960).

The crystallization of the particles was studied at room temperature using X-ray diffraction and electron microscope methods. It was found to be associated with an increasing number of crystallized particles and not with the growth of crystalline regions within the particles. Freshly prepared aerosols consisted of crystalline and amorphous particles and the proportion of amorphous particles increased as the mean diameter decreased. Irradiation with X-rays accelerated the crystallization process. J.E.Caffyn

541.18 : 532.7

ELECTROSTATIC REPULSION BETWEEN DIFFUSE ELECTRIC LAYERS IN BILATERAL LIQUID FILMS. See Abstr. 12420

541.18

14145 UTILIZATION OF ORDER—DISORDER THEORY IN PHYSICAL ADSORPTION. I. FUNDAMENTAL EQUATIONS. S.Bumble and J.M.Honig.

J. chem. Phys., Vol. 33, No. 2, 424-31 (Aug., 1960).

The order—disorder theory of Hijmans and de Boer (Abstr. 7715-17 of 1960) is adapted to a description of equilibrium between a gas and a phase forming a localized submonolayer on an energetically uniform surface. Isotherm equations are derived for adsorption in the absence of lateral interactions, and in the presence of nearest- and next-nearest-neighbour interactions. The Langmuir and Fowler—Guggenheim equations result as special cases of the present treatment. The general theory is then applied to adsorption processes on sites in hexagonal configurations. A discussion of the resulting isotherm equations is presented.

541.18

14146 A PRECISION ADSORPTION APPARATUS FOR THE STUDY OF THE INTERACTIONS BETWEEN GAS ATOMS AND SURFACES. G.Constabaris, J.H.Singleton and G.D.Halsey, Jr.

J. phys. Chem., Vol. 63, No. 9, 1350-5 (Sept., 1959).

A precision apparatus for the study of the interactions between gas atoms and surfaces of low specific area is described. A low temperature adiabatic calorimeter is used as the sample cryostat and the precise techniques of gas thermometry are used for pressure measurement. The gas is metered into the system with an accurate gas transfer apparatus. Data for the measurement of known volumes, and of the apparent volume of a vessel containing a low specific area, highly graphitized carbon black, are given. These measure ments, made with different rare gases at various temperatures, indicate a precision of between 1 and 2 parts per 10 000. The apparent volume data are converted to the usual quantity of adsorbed volume to give toom temperature adsorption isotherms at coverages of less than 2% of the monolayer.

541.18

14147 THE QUANTUM MECHANICAL CORRECTIONS FOR THE HIGH TEMPERATURE VAN DER WAALS INTERACTION OF LIGHT GASES AND SURFACES. A NEW METHOD OF DETERMINING SURFACE AREA. M.P.Freeman.

J. phys. Chem., Vol. 64, No. 1, 32-7 (Jan., 1960).

An experiment is reported in which the exact magnitude of the effect of negative discrete levels in the potential energy well for gas—surface interaction is determined. The experiment involves the surface interaction of two kinds of gas molecules differing only in mass (H_2 and D_2 with about 1700 m^2 of a low ash charcoal surface) and the interpretation of the data with the high temperature equation of state for gas—surface interaction as properly modified for an "almost classical" quantum mechanical assembly. Quantitative agreement of certain independently obtained parameters indicates that the quantum mechanical equation of state for these light gases is at least as good as the classical equation has been for interpreting data for the heavier gases. Unexcepted verification of the 9-3 potential model is apparently found and a new unambiguously defined surface area is discussed.

541

14148 ADSORPTION OF HELIUM ON CARBONS: INFLUENC ON MEASUREMENT OF DENSITY.

F.A.P.Maggs, P.H.Schwabe and J.H.Williams.

Nature (London), Vol. 186, 956-8 (June 18, 1960).

The apparent dead-space in a conventional volumetric adsorp apparatus has been measured as a function of temperature by applying the gas laws to pressure—volume data at various temper tures for a given amount of helium enclosed within the apparatus. The apparent dead-space increases as the temperature falls, and this is interpreted as showing adsorption of helium by carbon. One group of carbons (including all activated carbons) adsorbs appreciable amounts of helium, whereas a second group shows no adsorption at 298° K. R.F.S.Hearm

541.

14149 ADSORPTION FROM LIQUID MIXTURES AT SOLID SURFACES. C.G.Gasser and J.J.Kipling.

J. phys. Chem., Vol. 64, No. 6, 710-15 (June, 1960).

There are at least four major factors which appear to be important in considering adsorption from the liquid phase on to solids: (a) the thickness of the adsorbed film, (b) the orientation c the adsorbed molecules, (c) the polarity of the solid surfaces, (d) the interaction between the liquid components. These factors probably are relevant in the choice of solutes designed to stabilize dispersions. Adsorption by charcoal from mixtures of benzene with each of the lower aliphatic alcohols is considered in the light of these four factors. Adsorption can be interpreted as being confined to a monolayer, the alcohol molecules being adsorbed wit the major axis parallel to the solid surface. The competitive adsorption is affected both by interaction between the liquid components and by strong interaction between the alcohol molecules ar oxide complexes on the adsorbing surface.

541

14150 OBSERVATIONS OF NUCLEAR RESONANCE IN ADSORBED GASES. A.A.Galkin and V.Matyash.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1332-4 (April, 1960). In Russian.

A spin-echo proton resonance spectrometer was constructed for measuring T_1 and T_2 in the range 10^{-4} to 10 sec, and to give an estimate of the self-diffusion constant (D), at 14 Mc/s and dowr to 20° K. Some results are given of T_1, T_2 and D for hydrogen, methane or water adsorbed on activated charcoal for monomolecul layers and as a function of pressure. A monomolecular layer of hydrogen has parameters similar to solid rather than to liquid hydrogen. It is suggested that the viscosity of adsorbed water is much greater than that of the liquid. J.G.Powl

541.

14151 ADSORPTION AND BONDING PROPERTIES OF CLEAVAGE SURFACES OF BISMUTH TELLURIDE.

D.Haneman.

Phys. Rev., Vol. 119, No. 2, 567-9 (July 15, 1960).

No measurable adsorption of oxygen, nitrogen, or carbon mon oxide was found for any of the clean surfaces produced. Water va had a very low sticking coefficient of the order of 10^{-5}. The resul are discussed in terms of the chemical bonding of bismuth tellurid It is concluded that the atoms on cleavage faces are in a saturated bond condition. See also Abstr. 14047

541.

14152 CHEMISORPTION OF CO ON Ni USING A RADIOACTI TRACER. A.D.Crowell.

J. chem. Phys., Vol. 32, No. 5, 1576-7 (May, 1960).

Describes a method of measuring the amount of adsorption without breaking the vacuum or exposing the specimen to contamin tion between measurements. With CO on Ni, total adsorption was 2-3 × 10^{14} adsorbed molecules per cm^2 with an activation energy o 25 000 cal/mole. G.I.W.Llewel

PHYSICAL METHODS OF CHEMICAL ANALYSIS

545

14153 DETERMINATION OF BORON CONCENTRATION IN GASEOUS MIXTURES USING A NEUTRON BEAM.
.Chudars, I.Taure, I.Mednis and O.Veveris.
tv. PSR Zinat. Akad. Vestis, No. 3 (152), 57-64 (1960). In Russian.

Alpha particles from the reaction $B^{10}(n, \alpha)Li^7$ were detected in ionization chamber with extra electrodes. In a mixture of BCl^3 h H^2, concentrations of BCl^3 from 0.5% to 50% can be measured ±5%; from 50% to 75% with ±20% accuracy. The construction and racteristics of the chamber are described. D.W.L.Sprung

545

14154 X-RAY FLUORESCENCE SPECTROSCOPY.
S.Caticha Ellis.
l. Fac. Ingen. Montevideo, Vol. 7, No. 3, 43-96 (June, 1959). In nish.

A critical review of selected topics. L.Pincherle

545

14155 TECHNIQUE FOR CALCULATING X-RAY INTENSITIES IN THE ELECTRON PROBE MICROANALYZER.
S.Birks.
appl. Phys., Vol. 31, No. 7, 1297-8 (July, 1960).

The expected intensity of X-radiation from an electron-mbarded target of known composition is related to the intensity tained from a pure standard by means of a calculable intensity nction. A graph of this function is presented together with amples of its use in microanalysis.

A.E.I. Research Laboratory

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14156 AN IONIZATION DETECTOR FOR PERMANENT GASES
J.E.Lovelock.
Nature (London), Vol. 187, 49-50 (July 2, 1960).

The detector consists of an ionization chamber of plane-parallel geometry through which the gas can flow, and it contains a source of free electrons. Collisions of electrons with molecules of contaminating gases are relatively non-elastic, and a larger proportion of electron energy is lost than in the case of the elastic collisions with pure A molecules. By feeding the ion chamber with 1-10 μsec positive pulses, little current will pass for pure A. With contaminant gases present, the electron energy is much reduced and more electrons can be collected during the pulse. Thus the current is related to concentration of the contaminant gas. Response curves and a scale drawing of the chamber are given. D.V.Mabbs

545 : 537.534

14157 ANALYSIS FOR TRACE IMPURITIES WITH THE AID OF THE MAGNETIC RESONANCE MASS SPECTROMETER. V.B.Fiks and G.E.Pikus.
Fiz. tverdogo Tela, Vol. 2, No. 4, 716-27 (April, 1960). In Russian.

The background current caused by ions scattered on the molecules and atoms of the residual gas forms the essential limitation of the mass-spectrometric method of such analysis. This background can be reduced most effectively by using several mass spectrometers as steps of a separating cascade for the successive separation of ionic beams by their masses. It is shown that this idea is inherent in the very principle of the magnetic resonance mass spectrometer, since each turn of ions can be converted to a "step" of a separation cascade. The basic layout of the apparatus is described, and its maximum sensitivity when applied to the analysis for trace impurities is examined.

GEOPHYSICS

550.3

14158 LONG-PERIOD SEISMIC WAVES FROM NUCLEAR EXPLOSIONS IN VARIOUS ENVIRONMENTS.
Oliver, P.Pomeroy and M.Ewing.
ience, Vol. 131, 1804-5 (June 17, 1960).

Large nuclear explosions in the solid earth, the hydrosphere, and e lower and upper atmosphere have generated seismic waves of riods greater than about 5 sec which have been detected at great stances from the source.

550.3

14159 THE PLANE N-LAYER PROBLEM OF THE REFLECTION SEISMIC WITH CONSTANT WAVEFRONT ELOCITY, ARBITRARY [DISCONTINUITY] INCLINES AND RBITRARY POSITION OF SOURCE. M.Weber.
itt. Inst. Geophys. E.T.H. Zürich, No. 36, 2-12 (Aug., 1959). German.

The two-dimensional problem is considered theoretically, and tΔt method for inclined layers in outlined. H.J.H.Starks

550.3

14160 LIMITATIONS ON THE COMPOSITION OF THE UPPER MANTLE. P.W.Gast.
geophys. Res., Vol. 65, No. 4, 1287-97 (April, 1960).

New determinations of the isotopic composition of strontium d of the concentration of K, Rb, Cs, Sr, and Ba rocks and meteores are given. The isotopic abundance of Sr^{87} in the upper mantle d the crust appears to be lower than that found for chondrites. urthermore, for a chondritic earth model, the concentrations of tassium, rubidium, and caesium in the earth's crust are anomalous hen compared with those of uranium, barium, and strontium. These o concurring arguments indicate that the upper mantle and crust the earth do not contain K, Rb, Cs, U, Ba, and Sr, in the proporons found in chondrites, and that the alkali metals are depleted lative to U, Sr, and Ba. This depletion may be an indication of a nchondritic earth composition; it may also result from an earth fferentiation in which K, Rb, and Cs were concentrated or retained the lower mantle.

550.3 : 538.56 : 621.391.8

PROPAGATION OF ELECTROMAGNETIC PULSES IN A HOMO-ENEOUS CONDUCTING EARTH. See Abstr. 12704

550.3 : 538.56

ON THE ELECTROMAGNETIC RESPONSE OF A CONDUCTING SPHERE TO A DIPOLE FIELD. See Abstr. 12694

550.3 : 538

14161 THE VECTOR FIELD PROTON MAGNETOMETER FOR I.G.Y. SATELLITE GROUND STATIONS.
I.R.Shapiro, J.D.Stolarik and J.P.Heppner.
J. geophys. Res., Vol. 65, No. 3, 913-20 (March, 1960).

By applying homogeneous bias fields to a proton precessional magnetometer, vector magnetic field measurements of exceptional accuracy can be obtained. A vector proton magnetometer that has been in operation at nine Minitrack stations since the spring of 1958 is described.

550.3

14162 ANISOTROPY OF SUSCEPTIBILITY AND THE NATURAL REMANENT MAGNETISATION OF SOME WELSH SLATES. M.D.Fuller.
Nature (London), Vol. 186, 791-2 (June 4, 1960).

Investigates the effect of the deformations associated with mountain-building upon the anisotropy of susceptibility and the natural remanent magnetism of some samples of Lower Palaeozoic Welsh slates. S.J.St-Lorant

550.3

14163 OBSERVATION OF MAGNETIC CHRONIC DRAG OVER GEOLOGIC TIME. N.Kawai and S.Kume.
J. Phys. Radium, Vol. 20, No. 2-3, 258-61 (Feb.-March, 1959). In French.

To study the magnetic after-effect in low fields and at room temperature, rock specimens were kept for several years in a fixed position in the earth's field, and the change of magnetization measured. The measurements were extended to a very long period of time by studying rock samples that had been reoriented at a previous date in their history. A qualitative interpretation is given.

550.3 : 551.5

GEOMAGNETIC FIELD AND IONOSPHERIC DRIFT. See Abstr. 14221

550.3 : 551.5

RING CURRENT AND THE OUTER ATMOSPHERE.

See Abstr. 14263

550.3

14164 THE RELATION BETWEEN H- AND Z-VARIATIONS NEAR THE EQUATORIAL ELECTROJET.

C.A.Onwumechilli.

J. atmos. terrest. Phys., Vol. 16, No. 3-4, 274-82 (Nov., 1959).

The parallelism in the variations of the geomagnetic horizontal component (H) and vertical component (Z), so obvious in the magnetograms of Ibadan, has been investigated. During daytime when the effect of the electrojet is dominant, H and Z vary proportionately. Numerous indentations of varying period and amplitude are a prominent feature of daytime variation curves of H and Z at Ibadan. Six hundred of these indentations have been measured and analysed. The indentations attain their maximal values simultaneously in H and Z. Within the limits of experimental error, in 86% of the cases during the day and 54% of those during the night, the indentations also begin and end simultaneously in H and Z. The ratio r of the amplitude of an indentation in H to the amplitude of the same indentation in Z exhibits a remarkable diurnal variation, being constant for most of the daytime. The average value is 2.114 ± 0.021 during daytime and 4.112 ± 0.095 during the night. The ratio r is surprisingly independent of magnetic disturbance but decreases with increase in the period of duration T. For indentations of short periods T (e.g. not exceeding 15 min) the ratio r equals the ratio R of the diurnal range of H to the range of Z on undisturbed days. It is suggested that the indentations are caused by fluctuations in the quantity and quality of ionizing agents from the sun and that the decrease of r with increase in T is associated with vertical movements of the E-layer of the ionosphere (or the S_q-layer).

550.3

14165 CORRELATED MICROPULSATIONS AT MAGNETIC SUDDEN COMMENCEMENTS.

W.K.Berthold, A.K.Harris and H.J.Hope.

J. geophys. Res., Vol. 65, No. 2, 613-18 (Feb., 1960).

By the use of very large loops of wire, many square miles in area, nearly simultaneous micropulsations were recorded in Arizona and New Jersey during the initial phase of a magnetic storm. Evaluation of the two records (15 minutes' recording time) by cross correlation showed a time difference in arrival of common signals of 2 to 3 seconds. A similar difference was observed for the sudden commencement itself. The method used is simple and relatively unaffected by interference. The maximum sensitivity, 1.7 × $\times 10^{-4}$ gamma sec^{-1} mm^{-1}, could be used only during magnetically quiet periods. At two other sudden commencements, a remarkable resemblance was found in the fine details at the variations present. The overall study includes effects from both natural and man-made causes.

550.3

14166 STUDIES ON SUDDEN COMMENCEMENTS OF GEOMAGNETIC STORMS USING I.G.Y. DATA FROM UNITED STATES STATIONS. S.Matsushita.

J. geophys. Res., Vol. 65, No. 5, 1423-35 (May, 1960).

Contains studies of geomagnetic storm variations recorded at a network of seven I.G.Y. stations in the United States together with records for other observatories operated by the United States. The distance between adjacent stations of the network ranges from 360 to 510 km. Geomagnetic variations at these stations were usually quite similar, as would be expected. During magnetic storms, however, remarkable differences occurred even between adjacent stations. About half of the sudden commencements of the horizontal component showed different shapes at adjacent stations for the same magnetic storm. From the data obtained from these results, and from observations at more distant stations, the behaviour of sudden commencements is examined. The data also show that the variations of the vertical component of the sudden commencement differ in ways suggesting notable irregularities of the earth's conductivity in the central part of the United States. In addition, occasional examples of bay-shaped variations during magnetic storms, which are quite nonuniform over the closely spaced net, are illustrated and analysed.

550.3

14167 FLUCTUATIONS IN THE GEOMAGNETIC HORIZONTAL FIELD NEAR THE MAGNETIC EQUATOR.

A.Onwumechilli.

J. atmos. terrest. Phys., Vol. 17, No. 4, 286-94 (Feb., 1960).

Six-hundred fluctuations in the geomagnetic horizontal component (H) and vertical component (Z) have been measured from the magnetograms taken at Ibadan in April and May 1958. An analysis of these has shown that: (a) the frequency of occurrence varies with local time in the same way as S_q; (b) the amplitude of fluctuation increases in a general way with S_q; (c) the amplitude of fluctuatio in both H and Z tend to increase linearly with period in duration and there is some evidence for a change of slope at about T = 33 r with the fluctuations of longer duration increasing more slowly wi T than those of shorter duration; (d) fluctuations under quiet conditions occur mostly during day-time and are more frequent when S_q is high; (e) fluctuations during the night are of long duration an mostly occur during disturbance ($K_p > 3+$). It has been shown tha fluctuations under quiet conditions have the characteristics of sol flare effects and it is therefore suggested that both arise from sin causes.

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14168 OBSERVATIONS OF GEOMAGNETIC FLUCTUATION IN THE PERIOD RANGE 0.3 TO 120 SECONDS.

H.Benioff.

J. geophys. Res., Vol. 65, No. 5, 1413-22 (May, 1960).

Data are presented from a 5 year series of observations of geomagnetic fluctuations in the period range 0.3 to 120 sec approx mately. These were carried on with flux rate variographs using pickup coils with 1 sec period galvanometers recording photograp ically at a trace speed of 1 mm/sec with maximum sensitivies of 0.05 gamma/sec per trace millimetre. Four characteristic types oscillations are included in this study: Type A oscillations, appro mately sinusoidal in form, range in period from 0.3 to 2.5 seconds and in southern California occur at night only. They exhibit a neg tive correlation with sunspot numbers. Type B oscillations are nearly sinusoidal in form with periods ranging from about 3 to 8 seconds. They appear to be associated with the local occurrence of aurorae. Type C oscillations are nearly sinusoidal in shape wi periods ranging from about 7 to 30 seconds. In southern Californi they occur in daylight and exhibit a strong correlation with sunspo numbers. Type D oscillations are transients in the form of single or multiple pulses or trains of several oscillations. The pulse breadths or oscillation periods range from about 40 to 120 seconds or more. They are strictly nocturnal in southern California with sharp peak in the rate of occurrence at local midnight. Some char teristics of sudden-commencement components in the observed period range are mentioned briefly.

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14169 NOTES ON THE DISTRIBUTION OF SC* IN HIGH LATITUDES. T.Nagata and S.Abe.

Rep. Ionosphere Res. Japan, Vol. 9, No. 1, 39-44 (March, 1955).

Distribution of the preliminary reverse impulse of SC* of magnetic storms in the northern hemisphere is examined. The result shows that the equivalent overhead currents for the impulse are represented by current flows from 10h and 22h in the polar ca and the resulting two vortices extending to lower latitudes; a clock wise vortex in the afternoon and a weaker counter-clockwise one i forenoon.

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14170 EARTH'S MAIN MAGNETIC FIELD TO 152 KILOMET ABOVE FORT CHURCHILL. J.M.Conley.

J. geophys. Res., Vol. 65, No. 3, 1074-5 (March, 1960).

Proton precession magnetometers were flown in Nike—Cajun rockets at Fort Churchill, Canada, under magnetically quiet conditions in the daytime. The experimental data indicate that the earth's main field can be represented by an analytic function of the altitude provided that this is less than 150 km. A comparison of th results with the centred dipole field model is made.

S.J.St-Lora

550

14171 NOTE ON THE TIDAL THEORY OF THE S_q MAGNETI FIELD. R.L.Ingraham.

J. atmos. terrest. Phys., Vol. 16, No. 3-4, 263-73 (Nov., 1959).

The observed ratio of the diurnal to the semidiurnal componen of the S_q field is greater than unity, although a ratio of about a thou sand times smaller would be expected on order-of-magnitude tidal theory. An exact calculation using a dynamo theory was made with a certain analytically manageable model of diurnal and semidiurnal tides derived from the linearized Taylor—Pekeris theory to see whether "accidental" features might arise. It is shown that the an maly persists. Possible explanations of the puzzle based on the d tails of this tidal theory are suggested. (1) There may be a resona ting diurnal mode besides the well-established semidiurnal one.

Diurnal and semidiurnal motions rise to high maxima around lati- des 30°N and S and in the polar regions, respectively, as a result the rotation of the atmosphere. This feature is ignored in both der-of-magnitude theory and in the model. The diurnal maxima ould have much greater weight than the semidiurnal in the integral r the S_q field.

550.3

14172 ON THE POSITION OF THE FOCUS OF THE GEOMAGNETIC S_q CURRENT SYSTEM. M.Hasegawa.
geophys. Res., Vol. 65, No. 5, 1437-47 (May, 1960).

Reviews present knowledge about the S_q foci, discusses the use of changes in the S_q field, and describes problems concerning e determination of the S_q focus. It is concluded that the foci in e potential fields of geomagnetic D_q variations may be taken as proximately indicating the positions of ionospheric S_q current foci.

550.3

14173 ELECTROMAGNETIC INDUCTION IN A HEMISPHERICAL OCEAN BY Sq. T.Rikitake.
Geomagn. Geoelect., Vol. 11, No. 3, 65-79 (1960).

A theory of electromagnetic induction within a hemi-spherical onducting sheet is described. The theory is applied to the induction Sq in a large ocean of uniform depth bounded by two meridians. he patterns of the induced currents are obtained and illustrated oth for the 24-and 12-hourly components. Unlike the previous eories, the effect of self-induction, which turns out to be rather nportant, is fully taken into account. The magnetic fields produced the currents induced in the ocean amount to several gammas. he electric field in the sea associated with the induction would be the order of mV/km.

550.3

14174 GEOMAGNETIC DISTURBANCES AND 5 KILOCYCLES PER SECOND ELECTROMAGNETIC RADIATION. .R.A.Ellis.
geophys. Res., Vol. 65, No. 6, 1705-10 (June, 1960).

A comparison is made between variations of the geomagnetic eld and bursts of 5 kc/s radio noise recorded at Camden, N.S.W., etween June 1958 and October 1959. During this period 8 noise orms were recorded. All occurred during the main phase of a eomagnetic storm, beginning on the average 3 hours after the start the main phase. Of 97 isolated noise bursts of less than 4 hours' uration, 43 were associated with positive bays in the record of the agnetic H component. No consistent delay between the noise burst ad the bay was observed. Noise bursts were not in general associaed with geomagnetic micropulsations of less than 1-minute period, lthough some correlation with quasi-sinusoidal magnetic variations ith periods between 10 and 60 minutes was noted. During the eriod of the observations 30 magnetic sudden commencements were ollowed by noise bursts or storms after an average delay of 8.5 hours. n four occasions, a noise burst started immediately after a sudden ommencement occurring between 1200 and 1800 hours GMT.

550.3

14175 VARIATIONS IN THE GEOMAGNETIC FIELD AT IBADAN, NIGERIA. I. SOLAR VARIATIONS. C.A.Onwumechilli and N.S.Alexander.
J. atmos. terrest. Phys., Vol. 16, No. 1-2, 106-14 (Oct. 1959).

Magnetic records obtained at the recently established magnetic bservatory at Ibadan in equatorial Africa for the period November 955 to June 1957 are analysed harmonically for solar variations. The results, given in the form of harmonic dials, show that the amplitude of H is very large (similar to that observed at Huancayo), and the mplitude of Z is larger by a factor of 3 than any previously reported. These results are explained as arising from the equatorial electrojet entred on the magnetic equator, which is about $2\frac{1}{2}$°N of Ibadan. The ariation in D at Ibadan is small, but has its phase completely reersed between the June and December solstices. The D-variation hows no obvious effect of the electrojet.

550.3

14176 VARIATIONS IN THE GEOMAGNETIC FIELD AT IBADAN, NIGERIA. II. LUNAR AND LUNI—SOLAR VARIATIONS IN H AND Z. C.A.Onwumechilli and N.S.Alexander.
J. atmos. terrest. Phys., Vol. 16, No. 1-2, 115-23 (Oct., 1959).

Magnetic records obtained from November 1955 to June 1957 at Ibadan, Nigeria, have been analysed harmonically for lunar and uni—solar variations. The results are statistically significant. The L-variations in H and Z are abnormally large at Ibadan. The L-variation in H is comparable with that of Huancayo and about three-times greater than at other observatories of comparable geographic latitude. The L-variation in Z is larger than any previously reported. These results are explained as the effect of the equatorial electrojet. The ratio of S to L in H is small at Ibadan as at Huancayo. S/L in Z is equally small at Ibadan (of latitude where the Z effect of the electrojet is a maximum (Onwumechilli, 1959)). The Chapman (1913) expression for L is fully confirmed in all aspects.

550.3

14177 RAPID FLUCTUATIONS DURING MAGNETIC DISTURBANCE. J.Lawrie.
J. atmos. terrest. Phys., Vol. 17, No. 1-2, 145-9 (1959).

A numerically simple ratio is defined and used to examine space relationships of rapid geomagnetic fluctuations during disturbance.

550.3

14178 REGULAR MICROPULSATIONS OF THE EARTH'S FIELD AT THE EQUATOR. R.Hutton.
Nature (London), Vol. 186, 955-6 (June 18, 1960).

A study of the diurnal variation of occurrence of regular micropulsations of the earth's magnetic field at Legon, Ghana, shows that the phenomenon is not restricted to the daylight hours, but that such regular pulsations occur at night-time also.

S.J.St-Lorant

550.3

14179 PRELIMINARY REPORT OF GEOMAGNETIC OBSERVATIONS AT PRINCE HARALD COAST, ANTARCTICA. T.Nagata, T.Oguti and K.Momose.
Rep. Ionosphere Res. Japan, Vol. 11, No. 2, 41-9 (June, 1957).

The results of geomagnetic observation at Prince Harald Coast during the first Japanese Antarctic Research Expedition (1956/7) are briefly summarized. The geomagnetic total intensity around this region was found to be about 10% less than the value in the worldwide map by Vestine. Correlation between the geomagnetic phenomena and ionospheric ones and some characteristics of geomagnetic pulsations are discussed.

550.3

14180 DISTORTION OF THE MAGNETIC FIELD IN THE OUTER ATMOSPHERE DUE TO THE ROTATION OF THE EARTH. K.Maeda.
Rep. Ionosphere Res. Japan, Vol. 11, No. 3, 116-29 (Sept., 1957).

The paper deals with the possibility of shearing distortion of the magnetic equator in the outer atmosphere, which was suggested from the cosmic ray evidence revealed by Simpson. The magnetohydrodynamic wave equation is deduced and some approximations of the wave equation are discussed. Assuming a cavity surrounding the earth, which is formed due to the revolution of the earth, the fields are obtained, which must be generated by the non-axisymmetric component of the earth's dipole moment rotating with the earth. It is shown that by these fields induced inside and outside the cavity the dip equator is made to shift westwards in the outer atmosphere.

550.3

14181 METHOD OF MAGNETIC STORM FORECASTING FROM THE ACTIVITIES OF FLARES ACCOMPANIED BY SOLAR RADIO NOISE OUTBURSTS. K.Sinno.
Rep. Ionosphere Res. Japan, Vol. 11, No. 4, 195-204 (Dec., 1957).

A statistical study of the relationship between magnetic storms and flares accompanied by 200 Mc/s radio noise outbursts indicates a close connection.

550.3 : 551.5

SEVERE MAGNETIC STORMS; PROBABILITY OF SPREAD-F.
See Abstr. 14246

550.3 : 537.59

14182 ON THE MAGNETIC CLOUDS RESPONSIBLE FOR VARIATIONS OF COSMIC-RAY AND GEOMAGNETIC FIELD. M.Hirono.
Rep. Ionosphere Res. Japan, Vol. 11, No. 4, 205-28 (Dec., 1957).

It is shown that the solar magnetic energy is rapidly dissipated within twelve years due to the ejection of vast magnetic clouds as suggested by Morrison. The existence of any mechanism to replenish this rapid decay is doubtful. It is plausible that magnetic clouds of much smaller dimension and magnetic energy are intermittently ejected from the sun. These magnetic clouds are considerably slowed down by interplanetary gas. If the number density integrated near the sun in the direction of ejection is about $10^{20}/\text{cm}^2$

column, the magnetic cloud ceases to advance at about 1.5 A.U. from the sun and leaves a field free cavity behind it. This may explain some phenomena of the unusual increase of cosmic-ray intensity during a solar flare. The non-magnetized stream is not slowed down by interplanetary temperatures of $\sim 10^5$ deg K, and its slight separation from the magnetized parts of the stream is briefly discussed with regard to the progress of the geomagnetic and cosmic-ray storms.

550.9 : 539.1.07 : 539.16

RADIOACTIVE AGE OF PEGMATITE. See Abstr. 13163

ATMOSPHERE . IONOSPHERE

(Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

551.5 : 525 : 621.39

14183 THE N.A.S.A. SPACE SCIENCES PROGRAM.

Proc. Inst. Radio Engrs, Vol. 48, No. 4, 438-50 (April, 1960).

This report, prepared in April, 1959, summarizes the objectives of the space sciences programme of the U.S. National Aeronautics and Space Administration and the immediate and long-range plans for carrying out the programme. The report is divided into several broad areas; atmospheres, ionospheres, energetic particles, electric and magnetic fields, gravitational fields, astronomy, and biosciences. A review of present knowledge and existing problems in each of the above areas is included.

551.5

14184 A NEW DEW-POINT HYGROMETER.

N.R.Gokhale and K.M.Gatha.

Indian J. Meteorol. Geophys., Vol. 10, No. 3, 337-40 (July, 1959).

A new form of dew-point hygrometer has been developed to measure accurately the relative humidity of air inside small chambers. Its construction, assembly inside Millikan's oil-drop apparatus and operation are described. Its comparative merits are discussed.

551.5

14185 CONSTRUCTION AND CALIBRATION DETAILS OF THE THERMAL-TRANSDUCER-TYPE NET RADIOMETER.

L.J.Fritschen.

Bull. Amer. Meteorol. Soc., Vol. 41, No. 4, 180-3 (April, 1960).

The mica radiation window hitherto used is waterproof and has excellent solar transmission percentage but a strong absorption band at 8.8-10.3 microns and low transmission percentage at 10.3-15 microns. A comparison of radiation measurements was undertaken using mica and several different plastic windows. The Sarah Wrap type of plastic is waterproof and similar to mica for the solar-radiation range and superior for the terrestrial-radiation range. It also has an easier assembly. Construction and calibration details for this type are given and it is currently used to determine evapotranspiration energy of corn. R.S.Read

551.5 : 517

14186 A METHOD FOR ESTIMATING CONDITIONAL PROBABILITIES. I.A.Lund.

J. geophys. Res., Vol. 65, No. 6, 1723-9 (June, 1960).

A method is derived for estimating conditional probabilities in which relative frequencies from simple two-way contingency tables only are required. This method was tested on the problem of estimating the probability of four categories of temperature changes. The probability estimates were compared with the observed relative frequencies of the predictand.

551.5 : 523.74

14187 FURTHER EVIDENCE OF A SOLAR CORPUSCULAR INFLUENCE ON LARGE-SCALE CIRCULATION AT 300 mb. N.J.Macdonald and W.O.Roberts.

J. geophys. Res., Vol. 65, No. 2, 529-34 (Feb., 1960).

Statistical evidence from three successive winter half-years strongly indicates that, when the earth is bombarded by unusually intense solar corpuscular emission, certain troughs in the 300 mb circulation are subsequently amplified. The troughs so affected enter or are formed in the Gulf of Alaska—Aleutian Islands area on the second, third, or fourth day after the start of the corpuscular increases. The trough amplifications maximize a variable numbe of days later, which may explain why the result was not apparent earlier workers. The result has been found independently, at abo the same level of significance, in the data each of the three winter treated separately. For the data of three half-years grouped together the probability of such a strong chance association is less than 10^{-6}.

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14188 VERTICAL AIR FLOW OVER NORTH AMERICA.

A.Court.

J. geophys. Res., Vol. 65, No. 3, 947-57 (March, 1960).

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14189 THE MODES OF RELEASE OF AVAILABLE POTENT ENERGY IN THE ATMOSPHERE.

B.Saltzman and A.Fleisher.

J. geophys. Res., Vol. 65, No. 4, 1215-22 (April, 1960).

The space spectra of the fields of vertical motion and temper ture in the free atmosphere for February 1959 have been obtained and from these estimates made of the conversions between availa potential energy and kinetic energy as a function of wave number.

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14190 STATIONARY FLOW IN THE PLANETARY BOUNDA LAYER WITH AN INVERSION LAYER AND A SEA BREEZE. S.K.Kao.

J. geophys. Res., Vol. 65, No. 6, 1731-6 (June, 1960).

An analysis is made of the effects of an inversion layer and a sea breeze on the stationary flow in a planetary boundary layer. is shown that an intense temperature inversion virtually acts as a boundary surface which separates a planetary boundary layer into two layers. In the lower layer the flow is primarily thermally driven whereas in the upper layer the flow is similar to that in a boundary layer of a homogeneous fluid. A simple model is constructed to bring out the effects of the temperature inversion and the sea breeze on the stationary flow in the planetary boundary layer. A comparison of the observation and the theoretical model is made.

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14191 CARBONIC ACID NUCLEI.

G.Stetter.

Acta phys. Austriaca, Vol. 13, No. 2-3, 185-206 (1960). In Germa

The hypothesis is put forward that part of the atmospheric carbon dioxide exists as nuclei (Kohlensäurekerne), of particle siz less than 10^{-5} cm and approximately 10^9 particles per cm^3.

J.Hou

551

14192 RELATIONS BETWEEN THE ATMOSPHERIC OZONE AND TERRESTRIAL MAGNETISM. A.Vassy and I.Ras

C. R. Acad. Sci. (Paris), Vol. 250, No. 23, 3865-6 (June 8, 1960). In French.

Several specific cases of magnetic storms associated with an increase in the reduced depth of the layer of atmospheric ozone ar examined. The study, extending over a period of two years, appea to indicate a definite correlation between the two phenomena.

S.J.St-Lora

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14193 CALCULATION OF THE VERTICAL DISTRIBUTION O ATMOSPHERIC OZONE. G.F.Walton.

J. atmos. terrest. Phys., Vol. 16, No. 1-2, 1-9 (Oct., 1959).

The expressions which arise in the umkehr method A of determining the vertical distribution of ozone are evaluated and depicte as a set of curves. By means of these curves zenith sky measurements with the Dobson spectrophotometer can be quickly converte into ozone distribution for any value of the total ozone amount. Th method is applied to observational data from Ahmedabad and Oxfo

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14194 THE RATIO OF SODIUM TO POTASSIUM IN THE UPPER ATMOSPHERE. E.A.Lytle and D.M.Hunten.

J. atmos. terrest. Phys., Vol. 16, No. 3-4, 236-45 (Nov., 1959).

Since sodium in the upper atmosphere is observable by the resonance scattering of the D-lines, it is natural to inquire whether potassium might also be found. Of the likely sources for these su stances, sea-water has an atomic abundance ratio Na : K of 47 : 1, while the rest are in the range between 5 : 1 and 10 : 1. Consider tion of the chemical and ionic equilibria suggests that the ratio of e, neutral atoms in the upper atmosphere should be about the same in the source. The potassium resonance lines are at 7665 and 99 A; the former is the stronger but is obliterated by a strong line the atmospheric A-band. An infrared sensitive photomultiplier s used in a grating spectrometer along with a " condenser mory" permitting exposures to the twilight of 15 min or more. potassium line has been detected; maximum possible intensities ve been estimated from the tracings and for some occasions an per limit of 30 : 1 has been achieved for the Na : K ratio. This ggests that the source is sea-water. Some measurements of the ensity ratio of the two D-lines are also reported.

551.5

14195 TEMPERATURE GRADIENT AND ITS FLUCTUATION IN THE LOWER ATMOSPHERE.

Hirao, K.Akita and I.Shiro.

Radio Res. Lab. (Tokyo), Vol. 7, 1-7 (Jan., 1960).

The observations were made at Kokubunji for about two months. e relationship between them was examined. The result can be plained by the lateral movement of the atmosphere.

551.5

14196 ON THE STRUCTURE OF TURBULENCE IN ELECTRICALLY NEUTRAL, HYDROSTATICALLY STABLE AYERS.

H.A.Panofsky.

geophys. Res., Vol. 64, No. 12, 2195 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 ee Abstr. 10417 of 1960). There is evidence, both in the "stable" ratosphere and in stable layers in the atmosphere, that eddies n occur in horizontal planes with negligible vertical gust velocities d very little vertical mixing. Horizontal scales from 100m to -60 km are possible. J.G.Oldroyd

551.5

14197 TEMPERATURE CORRECTION IN THE ROCKET-GRENADE EXPERIMENT DUE TO THE FINITE-MPLITUDE-PROPAGATION EFFECT.

W.R.Bandeen and J.Otterman.

geophys. Res., Vol. 65, No. 3, 851-5 (March, 1960).

A method of applying finite-amplitude-propagation corrections the temperature values derived from velocity of sound measureents in the rocket-grenade experiment is described. Although mall, these corrections are not negligible, being of the same order magnitude as the probable error in the temperature determination om all other causes. The method is applied to one temperature rofile derived in a past rocket-grenade experiment.

551.5 : 539.17

14198 PHOTOGRAPHS OF THE HIGH-ALTITUDE NUCLEAR EXPLOSION "TEAK".

W.R.Steiger and S.Matsushita.

geophys. Res., Vol. 65, No. 2, 545-50 (Feb., 1960).

A sequence of four photographs of the August 1, 1958, hightitude nuclear explosion "Teak" near Johnston Island in the Pacific shown. These photographs were taken from Maui, Hawaii, at an titude of 3050 m and 1300 km from the explosion. Three main atures of these photographs are evident and are discussed: an roral arc directed southward; an expanding envelope; and an airow cloud. The auroral arc extending southward from the explosion interpreted as the glow produced by a stream of β-decay electrons rected along the earth's magnetic field. This arc apparently exnded into the southern hemisphere and was observed from Apia, amoa. The expanding envelope is interpreted as an excitation—ecombination phenomenon produced by an expanding shock front. y assuming an average speed of propagation of 1.3 km/sec of the ock front, the times at which the photographs were taken are stimated. The airglow cloud is interpreted as a residue of ionized aterial having a lifetime estimated at 15 to 30 min. Assuming an ectron density of 10 times the normal F2-region value, an effective ecombination coefficient of 10 times the normal F2 value is obtained he airglow cloud ascended at a rate of approximately 1000 m/sec d expanded horizontally at a rate of approximately 300 m/sec.

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14199 MOLECULAR OXYGEN DENSITIES IN THE MESOSPHERE AT FORT CHURCHILL.

E.Kupperian, Jr, E.T.Byram and H.Friedman.

atmos. terrest. Phys., Vol. 16, No. 1-2, 174-8 (Oct., 1959).

The transmission of solar radiation to ultraviolet photodetectors a rocket was used to obtain O_2 densities in the mesosphere. Densies between 70 and 86 km were lower by a factor of 1.8 in early ring than in midsummer. A temperature minimum of 186° K was served at 83 to 85 km in March. Dissociation appeared to begin ear 86 km in July and 96 km in March.

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14200 ION—ATOM INTERCHANGE.

D.R.Bates and M.Nicolet.

J. atmos. terrest. Phys., Vol. 18, No. 1, 65-70 (April, 1960).

It is argued that the ion—atom interchange processes of importance in the upper atmosphere (e.g. $O^+ + N_2 \rightarrow NO^+ + N$ and $O^+ + O_2 \rightarrow O_2^+ + O$) are very much slower than simple collision theory has led some aeronomists to suppose. The rate coefficients involved are thought to be sensitive to the temperature. Ion—atom interchange does not, as has been suggested, exercise an appreciable direct influence on the degree of dissociation of the nitrogen.

551.5 : 525

14201 DENSITY OF THE UPPER ATMOSPHERE AND ITS DEPENDENCE ON THE SUN, AS REVEALED BY SATELLITE ORBITS.

D.G.King-Hele and D.M.C.Walker.

Nature (London), Vol. 186, 928-31 (June 18, 1960).

Extends previous results (Abstr. 9062 of 1959; 4787, 8372 of 1960) giving revised values for air density at heights between 180 and 700 km deduced from orbital data of 21 satellites at dates up to March 1960, and describes two significant new features of the upper atmosphere which have now become apparent. Firstly, the wide variation of density between midnight and midday at heights above 500 km which had previously been noted for one satellite [L.G.Jacchia, Smithsonian Astrophysical Observatory Spec. Rep., No. 29 (1959)] has now shown itself for five other satellites, and the daytime and night-time values revealed by each conform to a consistant pattern. Secondly, at heights between 180 and 250 km, the average air density seems to have decreased by perhaps 20% between 1958 and 1960. This change is interpreted as the beginning of an 11-year cycle, maximum density occurring at the sunspot maximum in 1957-58. A.Boksenberg

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14202 SUNRISE AND ECLIPSE EFFECTS ON THE IONOSPHERE AT BRISBANE.

G.G.Bowman.

Austral. J. Phys., Vol. 13, No. 1, 52-68 (March, 1960).

A rotating spaced-loop direction-finding system, located at Brisbane, has been operated to investigate sunrise effects by using pulsed 3.84 Mc/s transmissions, (a) at normal incidence and (b) at oblique incidence. For oblique-incidence recording the transmitter was located at Armidale (bearing 202° and distant 355 km from Brisbane). Evidence is presented which suggests the formation (at both E and F2 layer levels) of several frontal irregularities, spaced some tens of kilometres apart, extending in directions parallel to the sunrise line and travelling, relative to the Earth, with this line. These fronts pass overhead at Brisbane approximately half-way between the 90 km level and ground level sunrise times. In the post-sunrise period, F2-layer spreading on the two-hop trace appears, and the spreading width increases for about 2 hr, suggesting an F2-layer ripple structure, with increasing ripple amplitude. The post-sunrise sporadic E occurrence suggests frontal irregularities, lying close to the sunrise line direction, soon after sunrise, but indicates a swing in direction as time progresses. Rotating-loop normal-incidence transmissions were also used to investigate effects due to an eclipse of the sun, at Brisbane, on 8th April, 1959. Post-eclipse E- and F2-layer frontal irregularities, oriented in directions close to the line representing the end of eclipse in the region of Brisbane, suggest a mechanism operating as the eclipse ends, which is similar to that operating at sunrise. The possibility, that the ripple structure which produces night-time spread-F at Brisbane is generated at sunrise, is discussed.

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14203 LANGMUIR PROBE MEASUREMENTS IN THE IONOSPHERE.

R.L.Boggess, L.H.Brace and N.W.Spencer.

J. geophys. Res., Vol. 64, No. 10, 1627-30 (Oct., 1959).

A rocket-borne (and free falling after ejection) dumbell shaped Langmuir probe has been used to measure electron temperatures and positive ion densities in the ionosphere(between 110 and 180 km). The two extreme hemispherical caps of the dumbell were information telemetry electrodes; the inner hemispheres and the cylinder joining them were guard electrodes. The probe characteristic was obtained by measuring the current between the information electrodes as the voltage between the information electrodes and between the guard electrodes was varied. R.W.Nicholls

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14204 A THEORY OF ELECTROSTATIC FIELDS IN THE IONOSPHERE AT NONPOLAR GEOMAGNETIC LATITUDES.

D.T.Farley, Jr.

J. geophys. Res., Vol. 65, No. 3, 869-77 (March, 1960).

The theoretical electrostatic coupling between the dynamo region and the F region of the ionosphere is examined at nonpolar geomagnetic latitudes. It is found that, under certain conditions, significant coupling between these two regions can occur at all latitudes, even for electrostatic fields with horizontal scale sizes as small as a few kilometres. The coupling is strongest at the poles and weakest at the equator. Strong coupling will also occur between magnetically conjugate portions of the F region, while weaker but significant coupling will exist between conjugate portions of the dynamo region. The strength of the electric source field which would be produced by an irregular, horizontally stratified wind in the dynamo region is then computed, both for polar and for nonpolar latitudes. The results indicate that, to a large extent, the polarization charge that the local winds attempt to build up leaks away vertically and forms closed current loops. In other words, the "internal impedance" of the thin source layer is greater than the "load impedance" presented by the rest of the ionosphere. Finally, the possibility that electrostatic fields may cause significant electron-density variations in the F region is examined briefly. It is concluded that they will not.

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14205 THE DETERMINATION OF IONOSPHERIC ELECTRON CONTENT AND DISTRIBUTION FROM SATELLITE OBSERVATIONS. I. THEORY OF THE ANALYSIS.

O.K.Garriott.

J. geophys. Res., Vol. 65, No. 4, 1139-40 (April, 1960).

Two techniques are described which permit the integral of the electron density up to the satellite height to be deduced from the satellite radio transmissions. One method is based on the rate of polarization rotation due to the Faraday effect. The other method depends on a measurement of the total angle of polarization at the time of closest approach of the satellite. If useful results are to be obtained, a number of corrections to assumptions made in the simplified analysis are necessary to account for path splitting between the two magneto-ionic components, error in the "high-frequency approximation", refraction, and satellite-aerial motion. Owing to the slow rotation of the satellite perigee position, the height of the passage at any given latitude varies. Variations of the integrated electron density with height can then be related to the electron-density profile. See also following abstract.

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14206 THE DETERMINATION OF IONOSPHERIC ELECTRON CONTENT AND DISTRIBUTION FROM SATELLITE OBSERVATIONS. II. RESULTS OF ANALYSIS.

O.K.Garriott.

J. geophys. Res., Vol. 65, No. 4, 1151-7 (April, 1960).

The results of observations of the radio transmissions from Sputnik III ($1958\delta_2$) in an 8-month period are presented. The measurements reveal the diurnal variation of the total ionospheric electron content; also, the ratio of the total content to the content of the lower ionosphere below the height of maximum density in the F layer is obtained. An estimate of the average electron-density profile above the F-layer peak is made possible by the slow variation in the height of the satellite due to rotation of the perigee position. The gross effects of large magnetic storms on the electron content and distribution are found.

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14207 IONOSPHERIC ABSORPTION INVESTIGATIONS AT HAWAII AND JOHNSTON ISLAND.

A.Fredriksen and R.B.Dyce.

J. geophys. Res., Vol. 65, No. 4, 1177-81 (April, 1960).

Measurements of ionospheric absorption by the cosmic-noise monitoring method show that, at certain latitudes, an irregular component of absorption is often present in the evening hours. If the variable absorption is present at one observing site (Johnston Island), then variations are also likely to be present at another station about 1325 km away (Hawaii). The individual variations of absorption as a function of time are not correlated at the two stations, however, suggesting that the scale of the patches causing the absorption must be less than about 1000 km. An attempt is made to find a correspondence hourly averages of the apparent absorption with other ionospheric parameters. Both a night time and day time absorption are observed. A greater night time component appears at Johnston Island than at Hawaii, implying the existence of a latitude dependence. Correlation with spread F or with sporadic E on the basis of ionosonde data from Maui was not found, although a correlation is appa ent between cosmic-noise absorption and ionosonde minimum refle tion frequency during geomagnetically quiet periods. There is goo correlation between average hourly values of the absorption and F_2 critical frequency f_0F_2. This latter observation is explainable by the shielding effect of the F region.

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14208 ANALYSIS OF PULSE-DELAY DATA FROM ROCKETS FOR THE DETERMINATION OF ELECTRON DENSITY.

W.Pfister and J.C.Ulwick.

J. atmos. terrest. Phys., Vol. 15, No. 1-2, 161-7 (1959).

Equations are derived for the positions of the ray path and the path length of the ray. These are used to derive the electron densit of the ionosphere between 90 and 135 km height using pulse-delay data from an Aerobee flight. The E-layer appears to have a laminated structure with 6 km between layers. R.D.Davie

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14209 A CONTRIBUTION TO THE THEORY OF THE MOTION OF WEAK IRREGULARITIES IN THE IONOSPHERE.

P.C.Clemmow and M.A.Johnson.

J. atmos. terrest. Phys., Vol. 16, No. 1-2, 21-36 (Oct., 1959).

The motion of weak irregularities in an otherwise homogeneou slightly ionized gas under the influence of electrostatic and magnet static fields is investigated. The governing equations are set out a the dispersion equation for harmonic plane wave solutions is obtain and solved. It is shown that, to a good approximation for ionospher applications, and with the neglect of diffusion, a plane wave travels with negligible attenuation with a velocity which is (a) proportional to the magnitude of the electrostatic field, (b) independent of the wavelength, (c) dependent on the direction of the wave-normal. As particular consequence, any weak two-dimensional irregularity whi is parallel to the direction of the magnetostatic field travels unchanged; so also does any one-dimensional irregularity, and in this case the analysis is unaffected by its strength. The effects of diffusion are examined.

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14210 NEW METHODS AND SOME RESULTS CONCERNING TRUE IONOSPHERIC HEIGHT CALCULATIONS.

W.Becker.

J. atmos. terrest. Phys., Vol. 16, No. 1-2, 67-83 (Oct., 1959).

The methods can be listed as follows: (a) Optical-graphical comparison method, comparing, for certain layer-types, calculated ordinary and extraordinary h'(f) traces with observed h'(f) records. It is possible to determine the best fitting layer-type and its parameters within 8 min. (b) General method, applicable to any monotonic h'(f) trace. This method is based on Rydbeck's solution of the respective integral equation. A 10 point h'(f) reduction according to this method takes 2 hr. (c) Correction method, combining the methods (a) and (b). Thus the time necessary for a 10 point h'(f) reduction can be reduced to 5/4 hr. The following results are reported: (a) Good agreement between actual layer shape and parabol N(h) distribution for the undisturbed night-time F-layer on 8 August 1957. (b) Periodic movements (T ~ 1 hr, amplitude ~ 8 km of the F-layer during a magnetically undisturbed night, 7-8 August 1957. (c) Sudden ascent of the F-layer during a "Polar Sudden Com mencement" (Δh ~ 60 km within ½ hr on 15-16 September 1956. (d) Existence of an N(h) minimum above the normal E-layer above Lindau, Germany, on 20 August 1957, 1545 hours.

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14211 ANOMALOUS IONOSPHERIC REFLECTION DURING SOLAR ECLIPSES.

W.L.Price.

J. atmos. terrest. Phys., Vol. 16, No. 1-2, 93-8 (Oct., 1959).

The appearance of complexities in ionosonde records has been ascribed by Munro to multiple reflections from inclined isoionic surfaces. Further extension of this work by Munro and Heisler has suggested that irregularities appearing on ionosonde eclipse record and affecting consequent interpretations may be due to a similar cause. In this paper a necessary relation between height and curva ture of the reflecting isoionic surface to produce complexities is deduced. It is further shown by calculating a typical set of isoionic contours for solar eclipse conditions that the necessary height curvature relation is satisfied at certain regions within the eclipse zone so that complexities can occur.

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14212 THE EFFECTS OF A SOLAR ECLIPSE ON A STRATIFIED IONOSPHERE. J.A.Gledhill.
J. atmos. terrest. Phys., Vol. 16, No. 3-4, 360-6 (Nov., 1959).

The effects of an eclipse on a simple three-layer ionosphere, in which the recombination coefficient decreases with height, have been computed. The results are displayed in the form of a contour map and show relatively large tilts of the isoelectronic surfaces near the layer maxima. The development of a "valley" between the F1- and F2-layers after the maximum of the eclipse is of particular interest. It is pointed out that such a valley may cause considerable errors in the interpretation of the behaviour of the F2-layer.

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14213 THE BEHAVIOUR OF THE IONOSPHERE OVER CAPE TOWN AND JOHANNESBURG DURING THE ANNULAR SOLAR ECLIPSE OF 25 DECEMBER 1954. J.A.Gledhill.
J. atmos. terrest. Phys., Vol. 16, No. 3-4, 367-75 (Nov., 1959).

Data are presented showing the variation of the critical frequencies for the ordinary ray in the E-, F1- and F2-regions at Cape Town and Johannesburg during the eclipse of 25 December 1954. The maximum obscuration was 79% at Cape Town and 68% at Johannesburg. It was not possible to deduce a solar model which would account satisfactorily for the data from both stations and those from Grahamstown, published earlier. Reasons are given for believing that oblique reflections affected the records and it is pointed out that the plot of f_0E versus f_0F1, used by Minnis to justify neglect of these reflections, is in fact not linear throughout an eclipse. There is some evidence for a high value of the recombination coefficient, 4×10^{-8} cm^3 sec^{-1}, in the E-layer.

551.5 : 523.16

14214 THE CORRELATION OF BURSTS OF SOLAR RADIO EMISSION IN THE CENTIMETRE RANGE WITH FLARES AND SUDDEN IONOSPHERIC DISTURBANCES.
O.Hachenberg and A.Krüger.
J. atmos. terrest. Phys., Vol. 17, No. 1-2, 20-33 (1959).

From statistical investigations of solar flares, of bursts of solar radiation in the centimetre range and of the accompanying effects of sudden ionospheric disturbances (SID) recorded during the first 6 months of the I.G.Y., it follows that there exists a close correlation between bursts in the centimetre range and SID. Only those flares, which give rise to a centimetre burst, are also able to cause a SID. Both flares and the ionizing radiation of the ionospheric D-layer have their origin in the chromosphere. The close correlation confirms the view that the ionizing radiation as well as the centimetre radiation of the flares are generated by super-thermal electrons. The ionizing radiation is evidently a "Bremsstrahlung" of the X-ray region.

523.16 : 551.5

THE CORRELATION OF BURSTS OF SOLAR RADIO EMISSION IN THE CENTIMETRE RANGE WITH FLARES AND SUDDEN IONOSPHERIC DISTURBANCES. See Abstr. 14214

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14215 THE CALCULATION OF REAL AND VIRTUAL HEIGHTS OF REFLECTION IN THE IONOSPHERE.
J.E.Titheridge.
J. atmos. terrest. Phys., Vol. 17, No. 1-2, 96-109 (1959).

A rapid and accurate manual method is described by means of which the heights h corresponding to a given series of electron densities N can be calculated from an ionogram which shows the h'(f) curve for the ordinary or extraordinary wave. The method makes allowance for the presence of the earth's magnetic field. The virtual height is read only once at about twenty frequencies, and the calculation of a complete N(h) curve requires less than 15 min. A slightly modified method is described for use when very accurate results are required, as, for example, in a study of the fine structure of the E-layer. The method makes use of a series of coefficients which may be quickly calculated once and for all, for a given place, with the aid of a desk calculating machine. The law assumed for the shape of the segments used in the analysis eliminates the necessity for the calculation and subsequent integration of the group refractive index in deriving these coefficients. The coefficients for the extraordinary wave are readily obtained by applying a correction to the "longitudinal" expression for the group refractive index. It is shown how the same coefficients can be used in the inverse process of deriving an h'(f) curve from a known N(h) curve.

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14216 THE USE OF THE EXTRAORDINARY RAY IN THE ANALYSIS OF IONOSPHERIC RECORDS.
J.E.Titheridge.
J. atmos. terrest. Phys., Vol. 17, No. 1-2, 110-25 (1959).

When the ordinary ray trace on an h'(f) record is used to compute an electron density profile (N(h) curve) assumptions have to be made about (a) the form which the h'(f) curve would have taken at frequencies less then those actually employed, and (b) whether or not there is appreciable ionization in the "valley" between the E- and F-layers. In this paper it is shown how, by considering both the ordinary and extraordinary ray traces on the h'(f) record, it is possible to avoid both these assumptions to a considerable extent, and to deduce something about the electron distribution in the lower ionosphere and in any valley. The method is applied to some experimental records, and it is shown (a) that neglect of the low-lying ionization leads to an overestimate of the height of the night-time F-region ionization of about 20 km where the plasma frequency is 2 Mc/s, and up to 15 km near the peak of the layer, and (b) that the "valley" between the E- and F-layers is small and nearly "full".

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14217 IONIZATION BELOW THE NIGHT-TIME F-LAYER.
J.E.Titheridge.
J. atmos. terrest. Phys., Vol. 17, No. 1-2, 126-33 (1959).

By making use of both the ordinary and extraordinary ray traces on h'(f) records it is possible to estimate the amount and distribution of low-lying ionization, having plasma frequencies less than the lowest frequency recorded. By applying this method to h'(f) curves obtained at night, it is possible to estimate the electron content of the E-region even when its critical frequency is less than the lowest recorded frequency. Results are given for Slough and Watheroo for both summer and winter conditions, and for maximum and minimum sunspot numbers. Near midnight the amount of ionization below the F-region is equivalent to a constant density of about 4000 electrons/cm^3 extending down to a height of 130 km. The variation in the amount of this ionization near sunset gives a constant effective recombination coefficient of 2×10^{-8} cm^3 sec^{-1}. F-layer heights calculated from the ordinary ray trace only are found to be too great by about 30 km at $f_N = 1$ Mc/s and 5 km at $f_N = 6$ Mc/s.

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14218 THERMAL AND GRAVITATIONAL ATMOSPHERIC OSCILLATIONS — IONOSPHERIC DYNAMO EFFECTS INCLUDED. M.L.White.
J. atmos. terrest. Phys., Vol. 17, No. 3, 220-45 (Feb., 1960).

The resonance theory of gravitational and thermal oscillations in a rotating atmosphere composed of a neutral gas (Sen and White, 1955; White, 1956) is extended to include an electron and positive ion gas with a permanent magnetic field superposed (so-called dynamo effect, Chapman and Bartels, 1940). Basic equations of energy and motion are given, resulting, for example, in a Kirchhoff's voltage law for the upper atmosphere. Height dependent expressions are obtained for the electric field, the current density, the ion drift velocities and non-linear heat source functions $\bar{q}_w$ $\bar{q}_n$ for the gas-as-a-whole and the neutral gas component. The $\bar{q}$-functions are produced by an I^2R power loss. The conditions under which one obtains the previous time-independent differential wave-equation of Wilkes (1951) and Sen and White (1955) are discussed; it is required that the thermal source function $\bar{Q}$ include a $\bar{q}$ function, resulting in two coupled wave-equations, one for the gas-as-a-whole and another for the neutral component. Using a method of operators, a time-dependent differential wave-equation is obtained from the time-independent wave-equation. It is found as a sufficient condition that if the four independent space and time variables in the non-linear $\bar{q}$-term are separable, then the oscillations satisfy the condition for neutral stability. Finally, a non-equilibrium "solution" for formation of ionized layers, based on the electron continuity equation, "tidal" transport terms included, is illustrated, using a method of successive approximation. Tables of the daily electron density variations at given true heights and the daily surface pressure variations are examined for predicted non-linear effects. One consequence is an explanation of the major contribution to the 6 hr surface pressure variation as a self-coupling of the important 12 hr pressure variation.

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14219 A THEORETICAL CURRENT DENSITY ANSATZ FOR THE QUIET DAY SOLAR SEMI-DIURNAL TIDAL MODE OF OSCILLATION OF THE IONOSPHERE. S.Shanack.
J. atmos. terrest. Phys., Vol. 17, No. 4, 337-44 (Feb., 1960).

A theoretical current density ansatz incorporating the atmospheric tidal resonance theory of Pekeris (1937) into the steady-state form of the "generalized Ohm's law", based on a number of simplifying physical assumptions, is obtained. The result is an embodiment of a generalized atmospheric dynamo mechanism of the origin of the upper atmospheric current systems. The horizontal (co-latitudinal and longitudinal) components of this current density are numerically integrated over an ionized spherical shell concentric with the earth, resulting in approximate expressions for the current density. Various applications of these approximate expressions are mentioned.

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14220 GYRO SPLITTING OF IONOSPHERIC ECHOES.

G.R.A.Ellis.

J. atmos. terrest. Phys., Vol. 18, No. 1, 20-8 (April, 1960).

The propagation of extraordinarily polarized waves in the ionosphere is discussed. It is shown that the properties of highly retarded F-region echoes sometimes observed at frequencies just below the gyro-frequency may adequately be explained if they are caused by the reflection of the X-wave at the normal extraordinary reflection level. Anomalous M-type multiple echoes and the mixed polarization of the echoes previously observed which had led to other explanations are interpreted in terms of mode change as a result of coupling in the E-region. The analysis shows that the zenith angle of arrival of the gyro echoes is not zero and increases as the gyro-frequency is approached. Observations of gyro echoes at frequencies up to 1.51 Mc/s are described. It is found that there is a strong correlation between the occurrence of gyro echoes above 1.45 Mc/s and of sporadic-E echoes.

551.5 : 550.3

14221 GEOMAGNETIC FIELD AND IONOSPHERIC DRIFT.

S.N.Mitra and K.K.Vij.

J. Inst. Telecomm. Engrs (New Delhi), Vol. 6, No. 2, 90-6 (Feb., 1960).

Investigation of ionospheric drift by the spaced receiver technique, utilizing fading on pulsed transmission, has been in progress at the Research Department of All India Radio since January 1958, forming a part of its programme for the International Geophysical Year. There is some uncertainty as to the origin of this drift system at ionospheric heights. If the drifts were due to the effect of solar and lunar gravitational tides upon a uniformly rotating sphere, one would expect the drift vector to exhibit a predominant semi-diurnal periodicity. Experimental observation indicates that this is not always the case. In fact there is hardly any regular behaviour in diurnal variation of the phase of the drift system. It is queried whether the earth's magnetic field exercises any influence on the drift system by being responsible for irregular variation of its phase. Such an influence should exist since the ionosphere consists of charged particles. Correlation of the magnetic K index (Alibag figures) with the magnitude of the drift velocity was made to find any interdependence. The analysis showed that so far as the magnitude of the drift velocity is concerned, it is fairly independent of the variation in the values of K; in fact large magnetic storms have failed to produce any significant change in the magnitude of the drift velocity. The variation of east-west and north-south components of the drift velocity during a "quiet" day does not indicate any correlation with K; but on "disturbed" days the northward velocity of the north-south component increases in synchronism with increase in K.

551.5 : 523 16

14222 PRE-SC POLAR CAP IONOSPHERIC BLACKOUT AND TYPE IV SOLAR RADIO OUTBURST.

Y.Hakura and T.Goh.

J. Radio Res. Lab. (Tokyo), Vol. 6, 635-50 (Oct., 1959).

It has been discovered that the shortwave blackouts in the polar cap region often occur well prior to the sudden commencement of geomagnetic storms. This phenomenon, "pre-SC polar cap blackout", is closely correlated with the solar radio outburst of type IV. An explanation is presented in terms of a plasma cloud bearing disordered magnetic fields which is produced in conjunction with the solar flare. When the sunspot magnetic field preserving the coronal condensation is not strong enough for convection of material outflow such a cloud may be ejected from the condensation. Then, the type IV outburst is emitted as the synchrotron radiation of relativistic electrons in helical motion round the magnetic fields frozen within the cloud passing through the solar coronal region. On the other hand, accelerated by successive collisions with those turbulent magnetic fields, some protons can attain an energy high enough to break out of the cloud. They reach the earth well before the arrival of the parent cloud responsible for the geomagnetic storm, and intrude into the lower ionosphere to cause an abnormal increase of the electron density. This effect can be observed as the pre-SC polar cap blackout. A long microwave outburst and a sharp SID wil be observed in such case where the sunspot magnetic field is sufficiently strong, while neither type IV outpurst nor pre-SC polar cap blackout is expected. Other related phenomena such as the unusual cosmic noise absorption of type III, the increase of solar cosmic rays, and the ordinary cosmic ray storm may be explained consistently with the present views.

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14223 ENHANCED IONIZATION IN THE POLAR IONOSPHER CAUSED BY SOLAR CORPUSCULAR EMISSIONS.

T.Obayashi and Y.Hakura.

J. Radio Res. Lab. (Tokyo), Vol. 7, 27-64 (Jan., 1960).

New evidence indicating the existence of energetic solar particles associated with solar eruptions has been found from the analysis of world-wide data of ionograms. An outstanding enhancement of ionization in the lower ionosphere occurs in the polar regi with a delay of several hours after a large solar flare accompanied by major radio outbursts of type IV. Radio blackouts due to enhanced ionizations develop inside the whole polar cap without induc ing any marked geomagnetic activity. With the onset of a geomagnetic storm, however, the blackout region spreads from the polar cap to the so-called auroral zone. As the Dst-field of the geomagnetic storm develops, it comes down to considerably low latitudes forming a spiral shaped ionization pattern. The radio blackouts, which precede the onset of geomagnetic storms, may be termed polar cap blackouts because they are confined within the geomagnet latitude of about $60^0 \sim 65^0$, while those related to magnetic storms and auroral displays are the auroral zone blackouts. It is shown that the polar cap blackouts are caused by the invasion of energetic particles of the order of 10 ~ 100 MeV, generated in an agitated solar coronal plasma bearing magnetic fields, and that those particles precipitate on the polar ionosphere following nearly the Störmer orbits. For the auroral zone blackouts, an improved version of the Störmer theory is applied, in which the interesting behaviour of a charged particle in the distorted geomagnetic field i revealed. The remarkable equatorward shifting of the auroral zone and some peculiar increases of cosmic ray intensity during the main phase of magnetic storms are explained consistently by the decrease of geomagnetic cut-off for incoming particles owing to the contraction of the geomagnetic cavity. The energy spectrum of solar particles associated with solar flares is revealed from the present result together with all information at various observations related to solar and terrestrial disturbances. It is concluded that solar particles have a conspicuous suprathermal non-Maxwellian tail extending from a few keV up to relativistic energy range, thoug the bulk of corpuscular clouds consists of rather low energy particles and hence are likely to be in the Maxwellian distribution. Since the solar coronal gas preserving magnetic fields may be violently agitated at the time of great solar flares, the Fermi acceleration is operative and the particles may be raised from thermal to suprathermal energies. Those high energy particles reach the earth causing enhancements of solar cosmic rays, polar radio blackouts and aurorae. On the other hand, the corpuscular clouds consisting of low energy particles produce the Dst part of geomagnetic storms and also form barriers for intergalactic cosmic ray particles due to magnetic fields frozen in the clouds.

551.5 : 523.1

A RELATION BETWEEN SOLAR RADIO EMISSION AND POLA CAP ABSORPTION OF COSMIC NOISE. See Abstr. 12257

551.5 : 532.

IONOSPHERIC FLUID FLOW: EFFECT OF DENSITY VARIATION. See Abstr. 12406

551.5 : 621.391.812.

14224 THE USE OF POLARIZATION FADING OF SATELLIT SIGNALS TO STUDY THE ELECTRON CONTENT AND IRREGULARITIES IN THE IONOSPHERE.

C.G.Little and R.S.Lawrence.

J. Res. Nat. Bur. Stand., Vol.64D, No. 4, 335-46 (July-Aug., 1960).

A procedure is described for using the Faraday-rotation fadin of a satellite radio signal to measure the ionospheric electron content per unit column up to the height of the satellite. At freque as low as 20 Mc/s the rotation of the plane of polarization cannot assumed to be proportional to $\int NB \cos\theta \, dl$ along the line of sight.

The simplifying assumptions implied by this expression are avoided, and full account is taken of ionospheric refraction, using the collision-free form of the Appleton—Hartree equation. Results based on observations of 1958 δ2 are presented. The subsatellite electron contents have been derived throughout the satellite passes for heights both above and below the F-peak; the latter compare well with values derived from simultaneous ionograms. The method also permits the study of large-scale irregularities in electron content. Such irregularities, having lateral dimensions of a few hundred km and fractional deviations in subsatellite electron content of about 0.02, have been detected. Th present observations suggest that satellite polarization studies offer important advantages over other methods of investigating these irregularities.

551.5

14225 IONOSPHERIC INVESTIGATIONS BY THE METHOD OF VERTICAL SOUNDING AT THE TIME OF THE I.G.Y.

I.M.Boenkova.

Radiotekhnika, Vol. 15, No. 4, 18-20 (April, 1960). In Russian.

A description of the organization, methods and results of research by vertical incidence sounding, carried out as a result of the I.G.Y.

G.A.Chisnall

551.5

14226 THE FORMATION OF THE D REGION OF THE IONOSPHERE. M.Nicolet and A.C.Aikin.

J. geophys. Res., Vol. 65, No. 5, 1469-83 (May, 1960).

Radiations of solar origin penetrating below 85 km in the terrestrial atmosphere are: (1) X-rays of $\lambda < 10A$; (2) Lyman α; and (3) wavelengths greater than 1800 A. These radiations can ionize: (1) molecular nitrogen and oxygen; (2) nitric oxide; and (3) various atoms such as sodium and calcium. Molecular oxygen and nitrogen are also ionized by cosmic rays. The negative ion to electron ratio is important below 70 km and affects the electron distribution below that altitude. It is possible to explain normal conditions of ionization by cosmic rays and Lyman α. Conditions due to solar flares must be explained by X-rays. Above 85 km, the behaviour of the ionization is related to the formation of the E-layer.

551.5

14227 SOME CHARACTERISTICS OF THE D-REGION IONIZATION DURING AURORAL ACTIVITY.

W.Stoffregen, H.Derblom and A.Omholt.

J. geophys. Res., Vol. 65, No. 6, 1699-704 (June, 1960).

D-layer ionization during auroras was studied in the north of Sweden during the I.G.Y. It was found that this type of D layer is closely associated with sudden auroral increase. The lowest measured heights of this D layer are ~65 km. The latitude variations of this D layer are discussed. It seems likely that both primary electrons and secondary X-rays may contribute to the formation of the auroral D ionization down to 65 km.

551.5

14228 AN INVESTIGATION OF THE IONOSPHERIC D-REGION. J.A.Fejer and R.W.Vice.

J. atmos. terrest. Phys., Vol. 16, No. 3-4, 291-306 (Nov., 1959).

Two previously described methods of ionospheric investigation, the observation of weak echoes from the D-region (Gardner and Pawsey, 1953) and the measurement of ionospheric wave interaction (Fejer, 1955) are used to determine tentative profiles of electron density and collision frequency for the ionosphere below about 85 km.

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14229 PECULIARITIES OF THE IONOSPHERE IN THE FAR EAST: A REPORT ON I.G.Y. OBSERVATIONS OF SPORADIC E AND F-REGION SCATTER.

E.K.Smith, Jr and J.W.Finney.

J. geophys. Res:, Vol. 65, No. 3, 885-92 (March, 1960).

The results for the period October 1, 1957, to October 1, 1958, from the I.G.Y. V.H.F. oblique-incidence sporadic-E measurements programme which operated circuits at 50 Mc/s in the Far East and the Caribbean are reviewed. Sporadic E is found to be three to five times more frequent in the Far East than in the Caribbean for reflection coefficients of –20 to –80 dB relative to inverse distance. Negligible dependence of magnetic activity is observed in either area, but diurnal and seasonal variations are more regular in the Far East. It is suggested that this longitudinal difference may be due either to the influence of the East Asiatic monsoon, perhaps through the mechanism proposed by Martyn, or to the difference in the relationship of magnetic dip to geographic latitude in these two areas. A peculiar evening signal enhancement, referred to as the "Far Eastern anomaly" or the "evening signal anomaly", appeared quite regularly in the Far East, and pulse-delay measurements indicate the probable source of the reflection to be the F region. The corresponding effect in the Caribbean is about 100 times less frequent, if it exists at all. The ^{n}F (layer tilt) reflection mechanism proposed by workers at Stanford (California) does not appear too promising in this case, owing to the pulse broadening of the order of 1 msec which is normally encountered in the evening signal anomaly. A mechanism that would explain the structure of the observed signal involves reflection from field-aligned ionization similar to the mechanism invoked to explain the "low-latitude auroral echoes" observed at Stanford.

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14230 A DAILY INDEX OF SOLAR ACTIVITY BASED ON E-LAYER IONIZATION (JULY 1957-DECEMBER, 1958).

C.M.Minnis and G.H.Bazzard.

J. atmos. terrest. Phys., Vol. 17, No. 1-2, 57-64 (1959).

The electron density in a Chapman layer can be related to the intensity of the incident solar ionizing radiation. This relation has been adopted as the basis for computing a daily index of the radiation intensity using the critical frequency of the E-layer at Slough. Precautions have been taken to minimize errors due to irregularities in the behaviour of the layer and to the difficulty of identifying the E-layer cusp. The standard deviation of the residual errors in the index is estimated to be 2%. The index has been tabulated for the period 1 July 1957 to 31 December 1958.

551.5

14231 SOME MEASUREMENTS OF COLLISION FREQUENCY IN THE E-REGION OF THE IONOSPHERE. D.M.Schlapp.

J. atmos. terrest. Phys., Vol. 16, No. 3-4, 340-3 (Nov., 1959).

Measurements of collision frequency in the E-region were made by observing how the deviative absorption of a radio echo varied with its group path as a critical frequency was approached. The collision frequency at heights between 105 km and 120 km was found to vary with a scale height of about 16 km. In 1955, the collision frequency passed through a value of 2×10^4 sec^{-1} at a height of about 112 km. There is some evidence that, when the sunspot number is greater, the collision frequency at a fixed height is greater.

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14232 SPORADIC-E AS OBSERVED BY BACK-SCATTER TECHNIQUES IN UNITED KINGDOM.

E.D.R.Shearman and J.Harwood.

J. atmos. terrest. Phys., Vol. 18, No. 1, 29-42 (April, 1960).

Observation of sporadic-E clouds with a rotating-aerial back-scatter sounder enables a greater sample of E_s clouds to be studied than does the use of a vertical incidence sounder and permits the size, location and movement of clouds to be estimated. Limitations are introduced by finite aerial beamwidth and skip-distance effect. Multi-frequency operation eliminates the latter defect, and also permits ionization to be measured. Results obtained during the IGY with a single-frequency rotating-aerial sounder are presented, showing the diurnal, seasonal and geographical characteristics of E_s occurance. On particular occasions, movements have been tracked and under favourable conditions, the size and ionization of the clouds determined. Earlier results obtained with a fixed-direction aerial and multi-frequency technique show similar diurnal and seasonal trends, and illustrate the possibilities of the variable-frequency facility for simultaneous measurement of cloud size and ionization.

551.5 : 621.391.812.63

14233 NOTE ON A TEST OF THE EQUIVALENCE THEOREM FOR SPORADIC E PROPAGATION.

J.W.Wright and T.N.Gautier.

J. Res. Nat. Bur. Stand., Vol. 64 D, No. 4, 347-8 (July-Aug., 1960).

Analysis of two days (123 cases) of sporadic E observed simultaneously at oblique and vertical incidence verifies that the classical sec Φ relationship between top frequencies is roughly appropriate for sporadic E.

551.5

14234 THE EARLY MORNING E2-LAYER AND SOME EVIDENCE OF PRE-SUNRISE F-LAYER "SPLITTING".

P.Bandyopadhyay.

J. atmos. terrest. Phys., Vol. 16, No. 1-2, 84-92 (Oct., 1959).

Two early morning phenomena, one relating to the E2-layer cusps and ridges and the other to the F-layer traces as observed in the h'(f) records made at Haringhata (Calcutta), are described and discussed. The early morning E2-layer cusps and ridges are found to be a regular sunrise feature of the ionograms. They show marked seasonal variation of character and frequency of occurrence and are most prominent in winter. The early morning F-layer records show, also in winter, a peculiar kind of "splitting" which is quite distinct from regular F1-, F2-bifurcation. This F-layer "splitting" and its possible bearing on the E-layer phenomena described above are discussed. Representative ionograms of the two phenomena are given.

551.5

14235 MAGNETIC STORM EFFECTS ON THE F REGION OF THE IONOSPHERE. Y.V.Somayajulu.

J. geophys. Res., Vol. 65, No. 3, 893-5 (March, 1960).

Some preliminary results of the true-height analysis carried out for the F region of the ionosphere for Washington, D.C., during individual severe SC-type magnetic storms are presented.

551.5

14236 VERTICAL TRANSPORT OF ELECTRONS IN THE F REGION OF THE IONOSPHERE.

S.Chandra, J.J.Gibbons and E.R.Schmerling.

J. geophys. Res., Vol. 65, No. 4, 1159-75 (April, 1960).

From the equation of continuity for free electrons, an expression is developed for the vertical transport velocity which can be evaluated, subject to some limitations, from electron-density-height profiles. A few numerical computations of the vertical drift velocities determined for the four I.G.Y. stations Huancayo and Talara, Peru; Panama, Canal Zone; and Washington, D.C., are presented. It is shown that the velocity is predominantly downward during the night and upward during the day at the equatorial stations. There is an apparent phase reversal from summer to winter at Washington. The order of magnitude of the vertical-velocity amplitude is 25 m/s. There is substantial agreement between the values calculated here from ionospheric data and those deduced from S_q data on the dynamo theory.

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14237 DRIFT MEASUREMENTS AT KJELLER ON THE IONOSPHERIC F REGION. J.Becken and B.Mæhlum.

J. geophys. Res., Vol. 65, No. 5, 1485-8 (May, 1960).

A study of the drifts and structure of the amplitude pattern of the F_2 echo is presented. Some measurements on the sporadic F echo are also included. All the measurements were made at Kjeller, Norway.

551.5

14238 THE ELECTRON DENSITY DISTRIBUTION IN THE F-REGION OF THE IONOSPHERE. A.J.Hirsh.

J. atmos. terrest. Phys., Vol. 17, No. 1-2, 86-95 (Dec., 1959).

The suggestion of Bates and Massey that the F1- and F2-layers of the ionosphere are formed by a single type of radiation, ionizing an atmosphere in which the electrons are lost by a double process of charge exchange followed by dissociative recombination, is examined in numerical detail. It is shown that under certain circumstances this could lead to the type of h'(f) curve observed in practice. It is also shown that the magnitudes of some of the quantities involved must lie within certain ranges.

551.5

14239 A NEW THEORETICAL MODEL OF THE COMPOSITE F-LAYER. F.Mariani.

J. atmos. terrest. Phys., Vol. 16, No. 1-2, 160-73 (Oct., 1959).

A model of a composite F-layer is developed to explain both the regular behaviour of the F1-layer and the anomalies of the F2-layer. The bifurcation in the F1- and F2-layers arises as an effect of a discontinuity in the physical conditions of the upper atmosphere, namely a fairly rapid variation of the generalized recombination coefficient is $\alpha = \alpha_0 n \xi N^{-1} T^{-1}$, where n, N and T are respectively the particle concentration, the electron density and absolute temperature. Tidal movements have a smaller importance, because they cause only secondary perturbative effects.

551.5

14240 STUDY OF "WINDS" IN THE F-REGION OF THE IONOSPHERE DURING THE UNUSUAL DAYS IN THE I.G.Y.-CALENDAR. R.N.Singh and S.R.Khastgir.

J. atmos. terrest. Phys., Vol. 16, No. 3-4, 376-83 (Nov., 1959).

The three-spaced-receiver fading records were taken at Banaras with vertical pulsed transmission at 3.8-4.2 Mc/s during the regular world days, world meteorological intervals following the IGY-calendar and also during the SWI's. The records gave information about the movements of the F-region of the ionosphere during these unusual days. The velocity and the direction of the "wind" were obtained by the method of similar fades and the cross-correlation method. The experimental arrangements and the methods of measu ment have been described. Usually the velocity of the F-region "winds" was found to have high values during the world meteorologi intervals. The sudden reversal in the direction of the F-region "wi round the midnight hour was confirmed by the observations taken during the regular world days. The sudden reversal in the directi of the "wind" was found to be followed usually by extremely rapid random fading, indicating turbulence in the ionosphere. The fading records on the unusual days in the IGY-calendar have been classifi and fully discussed with reference to the random and steady movements of the irregularities which exist for a short time in the F-region.

551.

14241 AN ATTEMPT TO MEASURE THE COLLISION FREQUENCY OF ELECTRONS IN THE F-REGION OF THE IONOSPHERE. D.M.Schlapp.

J. atmos. terrest. Phys., Vol. 17, No. 3, 246-53 (Feb., 1960).

An attempt was made to measure the collision frequency (ν) of electrons in the F-region of the ionosphere by Appleton's method o observing changes in the logarithmic reflection coefficient log ρ associated with changes ($\Delta P'$) in the group path, and using the expr sion

$$\Delta \log \rho = -\frac{\nu}{2c} (\Delta P' - \Delta P).$$

It is shown that the experimental results were very variable and th the average of a large number behaves in a way which is not in accord with theory. It is shown that the experimental results were very variable and that the average of a large number behaves in a way which is not in accord with theory. It is concluded that, in the F-region, ν is less than about 5×10^3 sec^{-1} but that no reliable esti mates of its magnitude can be made by this method.

551.

14242 CORRELATION OF SPREAD-F ACTIVITY WITH F-REGION HEIGHT CHANGES.

M.S.V.Gopala Rao, B.Ramachandra Rao and P.Ramachandra Rao Pan

J. atmos. terrest. Phys., Vol. 17, No. 4, 345-7 (Feb., 1960).

A new scheme of spread-F indices is developed to suit the equatorial spread-F observations and applied to estimate the correlation coefficient between spread-F activity and F-region height changes.

551.

14243 THEORETICAL WORLD CURVES OF MAXIMUM ION DENSITY IN A QUIET F-REGION.

J.E.C.Gliddon and P.C.Kendall.

J. atmos. terrest. Phys., Vol. 18, No. 1, 48-60 (April, 1960).

The global variation of electron density in the F2-region is investigated on the assumption of uniform temperature, uniform attachment-type law of recombination, a diffusion coefficient varyi inversely as the density of neutral particles and a Chapman ionization law. Electron density is calculated as a function of altitude and of local time at a number of different latitudes for the equinox and solstices. World curves of maximum ion density are deduced and compared with Millington's curves (1932). The curves present here are "drawn out" in the east—west direction as appears to be the case with the corresponding curves obtained by ionosonde methods. Although the latter are plotted against the geomagnetic latitudes, this broad similarity seems to indicate that diffusion plays a significant part in the control of F2-ionization.

551.

14244 SPREAD-F IN BAGUIO THROUGH HALF A SOLAR CYCLE. V.Marasigan.

J. atmos. terrest. Phys., Vol. 18, No. 1, 43-7 (April, 1960).

A 6-year statistical survey was made. An attempt to explain the observed periodicity has been made by the randomness of density—distribution introduced by the predominance of collision—detachment and by the random downward velocities.

551.

14245 A STATISTICAL STUDY OF WORLD-WIDE OCCURREN PROBABILITY OF SPREAD-F. I. AVERAGE STATE.

T.Shimazaki.

J. Radio Res. Lab. (Tokyo), Vol. 6, 669-87 (Oct., 1959).

A statistical study of the occurrence probability of spread-F is made by the use of the IGY data for the whole world. The daily, latitudinal and seasonal variations of the probability are clarified. The comparison with the sunspot minimum year (1954) is also mad The statistical analyses are made for all sorts of days, including agnetically quiet or disturbed days. The result shows that all of he statistical properties greatly differ at higher and lower latitudes. his may suggest that the origin of spread-F essentially differs at hese two latitudes. The entry of charged particles into the upper tmosphere certainly causes the spread-F at higher latitudes, hile at lower latitudes the origin must be sought in the terrestrial tmosphere.

551.5 : 550.3

14246 A STATISTICAL STUDY OF WORLD-WIDE OCCURRENCE PROBABILITY OF SPREAD-F. II. ABNORMAL STATE N SEVERE MAGNETIC STORMS.

T.Shimazaki.

J. Radio Res. Lab. (Tokyo), Vol. 6, 688-704 (Oct., 1959).

An investigation is made into the correlation between the ccurrence probability of spread-F and the geomagnetic activity. The result shows that the correlation is strongly negative at lower atitudes (<20°), while it is strongly positive at latitudes between 20° and 60°. At higher latitudes (>60°), the correlation becomes egative again, but it is shown that the result is much influenced by he occurrence of "black-out". The abnormal state of the world's ccurrence probability in some severe magnetic storms is studied n full detail. The result can be well explained by the consideration hat the critical level of the charged particles penetrating into the pper atmosphere rises gradually with the decrease of latitude. At atitudes lower than a certain critical latitude, the effect of magnetic torms is not so appreciable.

551.5

14247 THE EFFECT OF THE F1-LAYER ON THE CALCULATION OF THE HEIGHT OF THE F2-LAYER.

M.D.Vickers.

J. atmos. terrest. Phys., Vol. 16, No. 1-2, 103-5 (Oct., 1959).

An approximate relationship between the estimated true height of the peak of the F2-layer and that given by assuming a single layer having a parabolic electron-density distribution is derived and compared with experimental data.

551.5

14248 THE "VALLEY EFFECT" IN THE INTERPRETATION OF IONOSPHERIC ECLIPSE RECORDS.

J.A.Gledhill and A.D.M.Walker.

J. atmos. terrest. Phys., Vol. 18, No. 1, 61-4 (April, 1960).

It is shown that if a valley develops between the F1 and F2 ayers during an eclipse it produces characteristic effects on the urves of electron density at fixed heights versus time deduced rom the ionograms. These curves show spurious maxima which re greatest at heights just above the valley and decrease with ncreasing height. The effects predicted correspond closely to hose observed in South Africa during the eclipse of 25 December 954.

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14249 A RELATIONSHIP BETWEEN SPREAD-F AND THE HEIGHT OF THE F_2 IONOSPHERIC LAYER.

G.G.Bowman.

Austral. J. Phys., Vol. 13, No. 1, 69-72 (March, 1960).

The variation, throughout the night, of range-spreading spead-F widths, at Brisbane, is investigated. Evidence is presented to support the hypothesis that the ripple amplitude of the spread-F ionospheric irregularities varies directly with the layer height. This leads to an association between the range-spreading width and the height of the layer. Certain aspects of frequency-spreading are also discussed.

551.5

14250 THE ION DISTRIBUTION ABOVE THE F_2 MAXIMUM.

F.S Johnson.

J. geophys. Res., Vol. 65, No. 2, 577-84 (Feb., 1960).

Observations of the ion distribution in the ionosphere indicate hat the distribution up to 550 km is controlled in part by changes in he recombination rate with altitude, although diffusion exerts an ncreasingly important influence above the F_2 maximum. It is further concluded that the ion distribution above 550 km is controlled by diffusion and not by recombination, although a further reduction in ecombination rate with increasing altitude does occur. Charge-exchange reactions between oxygen ions and hydrogen atoms at an ltitude near the base of the exosphere provide a source of thermal rotons which move upward along the magnetic field lines together with an equal number of electrons and produce a medium for the ropagation of radio whistlers. The computed distribution of protons and electrons is in reasonable agreement with whistler observations. The whistler medium is of telluric origin, and the source of ionization is the same as that for the F region. It is suggested that the region above 1800 km in which protons predominate over all other ions be called the protonosphere, to distinguish it from the lower ionized region normally referred to as the ionosphere.

551.5

14251 ABNORMAL FEATURES OF THE F_2 REGION OF THE IONOSPHERE AT SOME SOUTHERN HIGH-LATITUDE STATIONS.

R.G.Rastogi.

J. geophys. Res., Vol. 65, No. 2, 585-92 (Feb., 1960).

The variation of the midday value of the critical frequency of the F_2 layer (f_0F_2) with magnetic dip shows asymmetry between the northern and southern stations of the west (American) zone, but not of the east zone. The control by the earth's magnetic field is indicated in the latitudinal distribution of even the midnight values of f_0F_2. The diurnal variation of f_0F_2 at Port Lockroy shows abnormal minimum at midday and maximum at midnight during the summer months. These abnormal features of the F_2 layer at Port Lockroy are explained on the basis of the horizontal transport of ionization as guided by the earth's magnetic field.

551.5 : 523.74 : 621 391.812.8

14252 WORLD MAPS OF F_2 CRITICAL FREQUENCIES AND MAXIMUM USABLE FREQUENCY FACTORS FOR USE IN MAKING IONOSPHERIC RADIO PREDICTIONS.

D.H.Zacharisen and V.Agy.

J. geophys. Res., Vol. 65, No. 2, 593-5 (Feb., 1960).

A recent publication of the National Bureau of Standards is described which gives charts for use in predicting the classical F_2-layer maximum usable frequency for any sunspot number. The charts present f_0F_2 and the M 4000 factor at sunspot number 50, and the rates of change of these parameters with sunspot number. A short history of N.B.S. activity in this field is presented, together with a comprehensive list of publications giving methods and tools used in making predictions by various organizations throughout the world.

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14253 ASYMMETRY BETWEEN THE F_2 REGION OF THE IONOSPHERE IN THE NORTHERN AND SOUTHERN HEMISPHERES.

R.G.Rastogi.

J. geophys. Res., Vol. 65, No. 3, 857-68 (March, 1960).

The asymmetry in the seasonal variations of the critical frequency of the F_2 layer at high-latitude stations during the years of minimum sunspot number is described. The variations of the F_2 layer at pairs of stations similarly situated on opposite sides of the equator are studied for different hours of the day and for different stages of solar activity. During years of low sunspot number, the curves of seasonal variations of f_0E, f_0F_1 as well as f_0F_2 are very similar to each other, and the well known summer decrease of noon f_0F_2 is not present at southern stations. The various hypotheses advanced to explain the abnormalities in the F_2 region are examined to explain the asymmetry, and a plausible cause is suggested on the basis of wind systems in the F_2 region, mainly the horizontal transport of the ionization.

551.5

14254 SOME ABNORMALITIES IN THE VARIATIONS OF F_2-LAYER CRITICAL FREQUENCY DURING THE PERIOD OF HIGH SOLAR ACTIVITY OF SOLAR CYCLE 8-19.

Chun-Ming Huang.

J. geophys. Res., Vol. 65, No. 3, 897-906 (March, 1960).

Some abnormalities in the variation of f_0F_2 were observed at Taipei during the period of very high solar activity of solar cycle 8-19. They are the saturation effect of f_0F_2 (i.e., the increasing rate of f_0F_2 with respect to sunspot number is nearly zero at high solar activity), the occurrence of post-sunset peak of f_0F_2, and the increase in f_0F_2 during the ring eclipse. Variations of these phenomena are described, the close relationship existing among them is examined, and a probable explanation is given.

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14255 INFERRED TEMPERATURE VARIATIONS AT THE F_2 PEAK.

S.J.Bauer.

J. geophys. Res., Vol. 65, No. 6, 1685-90 (June, 1960).

Information on the ionospheric electron content deduced from the Faraday rotation of lunar radio reflections and ionospheric data obtained by vertical-incidence soundings are used to infer scale heights at the F_2 peak. The scale height is found to exhibit pronounced time variations that are interpreted as variations in the temperature at the F_2 peak. The average values of inferred scale heights at the F_2 peak are compared with scale heights of a model atmosphere based on recent rocket and satellite data and are found to lie within ±15% of the model values. One exception to this finding occurred on a day following a magnetic storm: on this day, the scale height was more than 30% higher than the model value. This difference suggests the possibility of a pronounced increase in ionospheric heating at such times.

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14256 GEOMAGNETIC DISTORTION OF THE F2 REGION ON THE MAGNETIC EQUATOR. II. H.Maeda.

J. Geomagn. Geoelect., Vol. 11, No. 1, 1-5 (1959).

For Pt I, see Abstr. 9072 of 1956. The daily variation of the F2 region on the magnetic equator was investigated using Huancayo data over one sunspot cycle. It was found that the type of the daily variation of f_0F2 shows a systematic change with the sunspot cycle and is fairly closely connected with the phase shift in the geomagnetic S_q variations.

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14257 ON THE SEASONAL AND NON-SEASONAL ANNUAL VARIATIONS AND THE SEMI-ANNUAL VARIATION IN THE NOON AND MIDNIGHT ELECTRON DENSITIES OF THE F2 LAYER IN MIDDLE LATITUDES. T.Yonezawa and Y.Arima.

J. Radio Res. Lab. (Tokyo), Vol. 6, 293-309 (April, 1959).

The noon and midnight electron densities of the F2 layer expected in middle latitudes in the northern and the southern hemisphere for epochs of sunspot number 100 and 0 have been calculated for each month from January to December using observational data at nine stations in the northern hemisphere and at eight stations in the southern hemisphere. These electron densities have been analysed into the seasonal and non-seasonal annual variations and the semi-annual variation. The seasonal annual component in the noon electron density is very marked for epochs of sunspot number 100 and reaches a maximum in December and a minimum in June, the amplitude rising to as high as 20% of the average over both hemispheres during the year. This component, however, becomes very small for epochs of sunspot number zero, and, though it attains a maximum around September, it is doubtful if this is significant. The electron density at midnight consistently shows a maximum near June irrespective of solar activity and the amplitudes amount to 56 and 45% of the averages for sunspot number 100 and zero, respectively. The non-seasonal annual component is comparable or even greater than the corresponding seasonal variation in the case of noon values, and consistently shows a maximum around December or January for noon and midnight electron densities irrespective of solar activity. It is possible to ascribe this component to the action of beams of charged particles. The semi-annual component is almost always somewhat larger in the southern than in the northern hemisphere, and in all cases it is comparable in magnitude to or even greater than the corresponding non-seasonal annual variations. The variation in the noon electron density reaches a maximum in mid-April and mid-October in epochs of sunspot number 100, but the phase of this variation lags somewhat behind in epochs of low solar activity with sunspot number zero. In the case of midnight electron density the times of maximum are reached in early May and November for sunspot number 100, but these are shifted to mid-June and mid-December for sunspot number zero.

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14258 ON THE SEASONAL AND NON-SEASONAL ANNUAL VARIATIONS AND THE SEMI-ANNUAL VARIATION IN THE NOON AND MIDNIGHT ELECTRON DENSITIES OF THE F2 LAYER IN MIDDLE LATITUDES. II. T.Yonezawa.

J. Radio Res. Lab. (Tokyo), Vol. 6, 651-68 (Oct., 1959).

In continuation of the previous work (see preceding abstract) in which middle latitude stations as a whole were treated as one group, the noon and midnight electron densities of the F2 layer observed in middle latitudes have been subjected to a similar analysis, dividing the observational stations into two groups with relatively high or relatively low latitudes, in order to see if any change with latitude exists. The average geographic as well as geomagneti latitudes of the respective groups are about 47° and 27°. In general the results here obtained agree qualitatively with those obtained in the previous paper, but the following may be worthy of notice: (1) The seasonal variation in the noon electron density in relatively high latitudes is very different from that in relatively low latitudes. In the former region it is very marked and attains its maximum around December in a period of high solar activity, but it becomes much smaller and rather random in a period of low solar activity so that its amplitude and phase are not well-defined, while in relatively low latitude regions it is rather conspicuous in a period of low solar activity and reaches a maximum around June but becomes insignificantly small in a period of high solar activity. (2) There seems to be no very great difference between the non-seasonal variations at noon in relatively high and low latitude regions, but it may probably be concluded that the non-seasonal variation at midnight is larger in relatively high latitudes than in relatively low latitudes. (3) One did not find any very great and systematic difference between the semi-annual variations in relatively high and relatively low latitude regions except that they are generally larger in the latter regions. This component is generally larger in the southern than in the northern hemisphere, and the phase of this variation lags more or less behind in the periods when the sun is less active and/or in the case of midnight electron density.

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14259 ON A METHOD OF SHORT-TERM PREDICTION OF f_0F2. H.Shibata and S.Watanabe.

J. Radio Res. Lab. (Tokyo), Vol. 7, 19-25 (Jan., 1960).

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14260 A CONSIDERATION OF THE MECHANISM OF ELECTRON REMOVAL IN THE F2 LAYER OF THE IONOSPHERE. II. T.Yonezawa.

Rep. Ionosphere Res. Japan, Vol. 9, No. 1, 17-37 (March, 1955).

For Pt I, see 9817 of 1954. Theoretical considerations of the mechanism of electron removal in the F2 region are made. The main observational facts obtained from data analysis are summarized as follows: (1) The temporal rate of electron disappearance is of the attachment type. (2) The value of the attachment coefficient is about 10^{-4} sec^{-1} at the 300 km level. (3) The value of the scale height associated with the decrease in the attachment coefficient with height is ~ 100 km. The most probable mechanism of electron removal, which consists of the charge transfer reaction between atomic ions of oxygen and neutral molecules of oxygen or excited nitrogen followed by the dissociative recombination between the resulting molecular ions and electrons, is examined to see whether it can well interpret these observational facts. It is concluded that there is at present no satisfactory theory of the electron removal in the F2 region which can yield a consistent picture of its mechanism.

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14261 THE DETERMINATION OF THE ELECTRON DISTRIBUTION IN THE UPPER IONOSPHERE FROM SATELLITE DOPPLER OBSERVATIONS. F.H.Hibberd and J.A.Thomas.

J. atmos. terrest. Phys., Vol. 17, No. 1-2, 71-81 (1959).

It is shown how the electron distribution in the upper regions o the ionosphere may be determined from simultaneous measurement of the Doppler shifts of radio signals of two different frequencies received from an artificial satellite. The method is illustrated in detail by computations made on the 20 and 40 Mc/s signals from Sputnik I.

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14262 ELECTRON DENSITY MEASUREMENTS IN THE UPPER IONOSPHERE USING THE FARADAY ROTATIO OF RADIO SIGNALS FROM ARTIFICIAL SATELLITES. D.McL.A.Wilson.

Nature (London), Vol. 186, 623-4 (May 21, 1960).

It is shown that the variation of the ionosphere with latitude an longitude must be taken into account for satellite passes near or below the peak of the F2 layer. Making due allowance for this in th analysis of records of satellite passes well above the F2 peak, it is stated that self-consistant results can be obtained from a very simple model of the upper ionosphere — above the F2 layer peak the electron density falls off with a scale-height of approx. 230 km, and the average ratio of total electron content above the peak to that below is 3.4 to 1. These results agree well with other measurements. A.Boksenber

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FARADAY EFFECT IN THE TRANSMISSIONS FROM FAST SPINNING SATELLITES. See Abstr. 12340

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14263 THE RING CURRENT AND THE OUTER ATMOSPHERE S.I.Akasofu.

J. geophys. Res., Vol. 65, No. 2, 535-43 (Feb., 1960).

It is shown that hydromagnetic propagation will enable the ear field at ground level to be affected with a lag of less than 1 minute by changes in electric currents far above the earth — for example, by a changing ring current with a radius a few times that of the earth. It is shown that a system of trapped high-speed charged particles, such as those in the Van Allen belts, involves electric current flow; the deciding factor is the curvature of the guiding lines of the geomagnetic field. Thus an enhancement of the Van Allen radiation belts will decrease the horizontal geomagnetic component. Such a change is observed during the main phase of a magnetic storm. A suggestion is made about the origin of trapped high-energy particles from the analysis of two large magnetic storms during the I.G.Y.

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14264 MAGNETIC STORMS AND THE VAN ALLEN RADIATION BELTS — OBSERVATIONS FROM SATELLITE 1958ϵ (EXPLORER IV).

P.Rothwell and C.E.McIlwain.

J. geophys. Res., Vol. 65, No. 3, 799-806 (March, 1960).

The changes in intensity of charged particles measured with two Geiger counters carried in Explorer IV, between 270 and 200 km above the earth's surface in August and September 1958, have been analysed. During magnetic storms marked decreases in the intensity of trapped charged particles were observed above about 000 km, at the fringes of the outer Van Allen belt over North America and Australia; at lower altitudes, where little trapped radiation is usually observed, the Geiger counting rates increased underneath the outer zone at magnetically disturbed times. After the great magnetic storm of September 4-5, 1958, there was a significant increase in the average energy of particles trapped in the outer zone. No changes of intensity of particles in the inner Van Allen belt were detected during the period of observation except after nuclear explosions. It is suggested that the intensity decreases observed from Explorer IV in the outer radiation zone are due largely to increased scattering and absorption of trapped charged particles produced by atmospheric heating and expansion at fairly high latitudes during magnetic storms. The intensity increases observed at low altitudes beneath the outer zone are probably due to particles scattered down from the trapping region above. The average particle-energy increase in the outer Van Allen belt after a strong magnetic storm may be due either to injection of energetic particles from the sun into the trapping zone or to some acceleration process connected with the magnetic disturbance. The absence of noticeable intensity changes in the inner Van Allen belt argues in favour of a cosmic-ray albedo neutron rather than a solar origin of inner-zone protons, particularly since there was considerable solar activity during August and September 1958.

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14265 DISTRIBUTION OF TRAPPED RADIATION IN THE GEOMAGNETIC FIELD.

S.Yoshida, G.H.Ludwig and J.A.Van Allen.

J. geophys. Res., Vol. 65, No. 3, 807-13 (March, 1960).

The altitude dependence (360 to 2090 km) of the intensity of geomagnetically trapped radiation as measured with Explorer I (satellite 1958α) is given for a number of geographic locations. It is found that all intensity data in the vicinity of the magnetic dip equator and over the full range of longitude and of altitude can be represented satisfactorily by a single function of the scalar magnetic field intensity B. The value of B at the lower boundary of the inner zone of trapped radiation is a monotonically increasing function of magnetic dip latitude; such data from all available geographic locations are well represented by a single curve.

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14266 BALLOON STUDY OF HIGH-ALTITUDE RADIATIONS DURING THE INTERNATIONAL GEOPHYSICAL YEAR.

J.R.Winckler.

J. geophys. Res., Vol. 65, No. 5, 1331-59 (May, 1960).

The results of a series of 85 constant level balloon flights conducted during the I.G.Y. period to measure cosmic rays and other types of radiation at high altitude are summarized. Each flight carried an ionization chamber, a Geiger counter, and nuclear emulsions, and remained at approximately 10 g/cm^2 depth for times between 2 and 24 hr. The majority of flights were made at Minneapolis, Minnesota. The large decrease in primary cosmic-ray intensity between 1956 and 1958 was observed at high altitude. The high-altitude measurements correlate with sea-level neutron instruments. Many special events were detected, including X-rays produced by electrons incident on the atmosphere during strong aurorae and solar cosmic rays detected on ten occasions and correlating with other known observations made in the polar regions. In one case γ-rays originating on the solar surface were detected in a short burst. Several cases of radioactive layers in the atmosphere at low level resulting from nuclear explosions were found. The entire programme is summarized and the instrumental details given; a summary of published information, and detailed analysis of many data not heretofore published is given.

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14267 OBSERVATIONS OF THE VAN ALLEN RADIATION REGIONS DURING AUGUST AND SEPTEMBER 1959. I.

R.L.Arnoldy, R.A.Hoffman and J.R.Winckler.

J. geophys. Res., Vol. 65, No. 5, 1361-76 (May, 1960).

An integrating ionization chamber and a single Geiger counter were flown on United States satellite Explorer VI in an elliptical orbit extending to 48 000 km. In addition to the Van Allen inner zone and the great outer zone, a stable and distinct intermediate zone was detected throughout August and September 1959. The outer-zone intensity showed a large decrease following the sudden commencement of a geomagnetic storm. Later in the storm the outer zone increased to much in excess of its prestorm level. During stable periods the outer zone was fairly constant and less intense than it had been observed to be with Pioneer III or Pioneer IV or the first Soviet cosmic rocket. Cosmic-ray background counting rates were reached on most passes in August and September near apogee of the satellite. The radiation "dumped" from the outer zone during the geomagnetic storm fits very well with the intensity and latitude distribution required to account for balloon observations of auroral X-rays made during the I.G.Y. period (see preceding abstract). This paper is based on preliminary analysis of Explorer VI data.

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14268 PARTICLE FLUXES IN THE INNER RADIATION BELT.

S.C.Freden and R.S.White.

J. geophys. Res., Vol. 65, No. 5, 1377-83 (May, 1960).

Using the albedo neutron decay source, the energy spectrum of trapped protons in the inner belt has been calculated from 10 to 700 MeV. This calculation differs from those of Singer (1958) and Hess (1959) in that a nuclear interaction term, in addition to the energy loss term, has been used in the continuity equation for the steady-state condition. The spectrum agrees well with the published data. This agreement is strong evidence for the albedo neutron decay source. It also indicates that nonadiabatic losses are small for the particles measured here. A second small stack of nuclear emulsions was flown at the lower edge of the inner radiation belt 11 days after the large solar flare of May 10, 1959. The ratio of the proton flux measured on the second flight to that on the first one is 0.8 ± 0.1, indicating that the solar flare had little or no effect on the proton content of the inner belt. A flux of 2 ± 1 tritons/cm^2 sec between 126 and 200 MeV was observed; it is attributed to collisions of trapped protons with air nuclei. No other nuclei heavier than protons were seen.

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14269 ON THE THEORY OF PROTONS TRAPPED IN THE EARTH'S MAGNETIC FIELD.

E.C.Ray.

J. geophys. Res., Vol. 65, No. 4, 1125-34 (April, 1960).

A differential equation of transport is written for protons losing energy in an atmosphere but not scattering. It is solved under the approximation that a proton loses a negligible amount of energy while it drifts once round the earth in longitude. Three cases are treated: the equilibrium solution with input and loss rates equal; the solution for impulsive injection at $t = 0$, the intensity then dying away; and the solution for the intensity zero initially, the input mechanism being turned on at $t = 0$. No numerical work bearing on the geometry of the source function is included. The treatment is an improvement over previous ones in that it adequately treats the particles as moving along their actual trajectories. A detailed comparison with observations over South Africa shows that the altitude dependence of intensity is roughly consistent with the view that the particles seen by the unshielded Geiger tube on 1958ϵ are protons supplied by a weak source (for example, by decay of albedo neutrons) which are lost to the detector when their energy is reduced below the detection threshold by absorption. The atmosphere required has a temperature of about 2000° K at 400 km if it is pure dissociated nitrogen. At some height between about 1100 and 1300 km the scale height sharply increases in a way consistent with the view that at this height the composition changes to pure dissociated hydrogen. Only relative intensities are used in these comparisons.

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14270 PHYSICAL STATE OF OUTER ATMOSPHERE AND THE ORIGIN OF RADIATION BELTS. T.Obayashi.

J. Geomagn. Geoelect., Vol. 11, No. 3, 80-4 (1960).

A possible mechanism of high energy particle trapping in the radiation belts surrounding the earth is proposed, taking into account the existing hydromagnetic waves in the outer atmosphere. It is shown that there are two regions where the amplitude of hydromagnetic waves and the compressibility of the gas containing the magnetic field are large. Since the acceleration mechanism is operative in such regions, particles inside the regions may be raised in energy, and consequently produce local inhomogeneities of the hot plasmas. These hot plasmas interact with the geomagnetic field and may form a certain kind of magnetic bottle, in which the high energy particles are trapped. The height of the inner activated region is expected to be ~ 1000-3000 km and that of the outer region to be ~ 20 000 km. Although the high energy particles probably originated by solar particle injection, their concentration at particular regions may be controlled considerably by the hydromagnetic nature of the outer atmosphere.

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TEMPORARY CAPTURE OF COSMIC RAY PARTICLES AND THEIR CONTRIBUTION TO THE HIGH INTENSITY BELTS. See Abstr. 13078

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14271 THE DETERMINATION OF THE ELECTRON DENSITY IN INTERPLANETARY SPACE. J.M.Kelso.

J. atmos. terrest. Phys., Vol. 16, No. 3-4, 357-9 (Nov., 1959).

A very high frequency pulse transmitted from the earth to a space vehicle at interplanetary distances will be subject to a delay exceeding that in free space by an amount proportional to the average electron density along the path. It is shown that this average electron density and the arc length of the ray path can be measured by transmitting a pulse to the vehicle on one frequency and transponding pulses from the vehicle on two frequencies. With sufficiently accurate measurements, the total electron content along the ray path through the ionosphere can be determined from such an experiment conducted from a high-altitude satellite.

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14272 BALLOON OBSERVATIONS OF X-RAYS IN THE AURORAL ZONE I. K.A.Anderson.

J. geophys. Res., Vol. 65, No. 2, 551-64 (Feb., 1960).

During high-altitude balloon flights made in the northern auroral zone, fluxes of X-rays have frequently been observed. By means of sodium iodide scintillation crystals and pulse height analysers also carried in the balloon instrumentation detailed measurements of the photon energy spectrum in the region 40 to 340 keV have been obtained. These X-rays generally appear without definite geophysical or solar correlation. They are believed to be directly related to the soft radiation investigated by rockoons and also to processes occurring in the outer Van Allen radiation zone. The rapid intensity and spectral fluctuations that are observed suggest that in addition some process, possibly atmospheric discharge, may also be important. The relation of these X-rays to visible aurorae is not clearly established here.

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14273 OBSERVATIONS OF THE AURORA AUSTRALIS AT NEW ZEALAND ANTARCTIC STATIONS DURING I.G.Y.

T.Hatherton and G.G.Midwinter.

J. geophys. Res., Vol. 65, No. 5, 1401-11 (May, 1960).

Intensive auroral observations at Scott Base and Hallett Station during I.G.Y. indicate that auroral activity is higher than has previously been estimated at these latitudes. The distribution of auroral activity is not simple; it appears to consist of two superimposed systems, one of isolated rays and the other of arcs and bands, symmetrical about different axes. Orientation of the principal arcs fits a zone which takes account of the nondipole field better than one based on the centred geomagnetic dipole, though the auroral frequencies conflict with this. Auroral activity increases with local geomagnetic disturbance at Hallett Station, but at Scott Base there is negligible increase in the probability of auroral occurrence until K = 5. However, the diurnal variation of auroral frequency, which is bimodal with the primary maximum at 04 hours local time and the secondary maximum at 17 hours local time, does not appear to be related to the diurnal trend of local geomagnetic disturbance, but the principal auroral events inside the zone seem to coincide with the principal magnetic events in the Stagg transition zone. The only characteristic coloured form observed, a pale red glow on the horizon, is associated with high magnetic activity and ionospheric absorption. The latitude of auroral forms decreases with increase in K index. The results are compared with those of previous expeditions to Ross Island and Cape Adare.

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14274 AURORAL AND NIGHTGLOW OBSERVATIONS AT ÅS, NORWAY. G.Kvifte.

J. atmos. terrest. Phys., Vol. 16, No. 3-4, 252-8 (Nov., 1959).

A new grating spectrograph has been used in the study of the upper atmosphere. A summary is given of the results of auroral observations. In a more detailed account of nightglow investigation are given precise wavelengths of the band lines of the 5,0, 6,1, 8,2 a and 9,3 bands of the Meinel OH system, and absolute intensities of the bands. From the intensity distribution of the lines within the 6,1 and 9,3 bands is derived a rotational temperature of the emitting layer of 215° K. A sharp H_α line and the red forbidden lines of N II are found to be present in the nightglow.

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14275 AURORAL IONIZATION AND THE ABSORPTION AND SCINTILLATION OF RADIO STARS.

H.J.A.Chivers and J.S.Greenhow.

J. atmos. terrest. Phys., Vol. 17, No. 1-2, 1-12 (1959).

Discusses the absorption of the radiation from extra-terrestria radio sources, when observed, at low elevations to the north of Jordell Bank (geomagnetic latitude 56°). At lower culmination the Cygnus radio source is at an elevation of only 4°, and the line of sight to the source then passes through the ionosphere near the zone of maximum auroral activity. Combined observations of the source intensity at 36 Mc/s and 100 Mc/s, and of radar back-scatter echoes at 36 Mc/s, have been made using the 250 ft steerable telescope. The absorption and certain back-scatter echoes can be related to an ionized layer at a height of the order of 100 km, associated with auroral activity. It is shown that with a high sensitivity radar equipment at 36 Mc/s, weak auroral-type echoes from irregularities in the E-region aligned along the earth's field occur on about 40 per cent of all days at quite low geomagnetic latitudes. The suggestion is made that the scintillation of radio stars observed from latitudes similar to that of Jodrell Bank is not due entirely to irregularities in the F-region, but that there is a large contribution from these aligned irregularities at E-region heights.

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14276 CHARACTERISTICS OF THE VISUAL AURORAE AT BYRD STATION, ANTARCTICA, DURING 1957.

D.P.Hale.

J. atmos. terrest. Phys., Vol. 17, No. 1-2, 65-70 (1959).

Characteristics of the visual aurorae observed at Byrd Station, Antarctica, located at 80°S latitude, 120° W longitude, during the last half of 1957 are discussed. Salient features of auroral activity variations in time, spatial and motion patterns, colour frequency, vortices, swirling rays, special forms and other aspects are delineated. The most active period over the season during the Greenwich sidereal day is from 0200 to 0600 GCT. Aurorae of asymmetric intensity relative to the geomagnetic meridian were observed, with the brightest portion about three times more likely to occur east rather than west of the meridian. Off-meridian aurorae and bands of long duration were observed. The direction of motion of features was overwhelming from west to east; and form were much more likely to drift northward than southward. A possible method for measuring ray-lengths employing but a single point of observation is sketched.

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14277 IONOSPHERIC THERMAL RADIATION AT RADIO-FREQUENCIES IN THE AURORAL ZONE. R.L.Dowden.

J. atmos. terrest. Phys., Vol. 18, No. 1, 8-19 (April, 1960).

Measurements of the temperature of the ionospheric D-region in the auroral zone from observation of 2 Mc/s radio noise are described and compared with measurements similarly made in the temperate region. The temperatures of the undisturbed and disturbed ionospheres at the two latitudes are found to be essentially similar, but the disturbing influence in the auroral zone is probably corpuscular rather than u.v. radiation.

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14278 SOME SPECTRAL STUDIES OF THE AURORA. R.C.Bless, C.W.Gartlein and G.Sprague.
Geophys. Res., Vol. 65, No. 2, 565-70 (Feb., 1960).

Some results of spectral studies of the aurora are discussed. e spectra, taken routinely since 1941, give a continuous spectral cord of the north sky for every night. Special emphasis was given e study of hydrogen, with two main results: hydrogen appears in e early part of an aurora, and may be gone before the visual display over; the absolute intensity of an aurora increases as the aurora pands outward from the pole. Sample intensity measurements are ven showing the time variation of various components.

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14279 AN ANALYSIS OF A SPECTROGRAM OF THE AURORA OF 11 FEBRUARY 1958, IN THE WAVELENGTH RANGE 710-4420 Å. L.Wallace.
. atmos. terrest. Phys., Vol. 17, No. 1-2, 46-56 (1959).

A spectrum of the early stages of the great aurora of 11 February, 958, covering the wavelength range 3710-4420 A at a dispersion of 2 A/mm shows several unusual features. The most striking of these re the lines of the 3d—4f transition array of N II which lie at exci- ition potentials 4-6 eV above those of the usually observed N II lines. he (0,0) and (0,1) bands of the N_2^+ first negative system indicate otational temperatures of from 225° K for the lines with low -numbers, to 575° for high K-numbers. The (2,12) and (1,12) egard—Kaplan bands of N_2 yield uncertain rotational temperatures ith a lower limit of 800° K.

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14280 TYPE-B AURORA IN THE ANTARCTIC. J.M.Malville.
. atmos. terrest. Phys., Vol. 16, No. 1-2, 59-66 (Oct., 1959).

Spectrograms obtained in the Antarctic during 1957 of aurorae ith red lower borders are described. The outstanding feature of his type of aurora is an enhancement of the first positive system f N_2. A reaction of mutual neutralization of the N_2^+ molecule by he O_2-negative ion is proposed to account for the observed enhance- nent. Assuming optimum values for rate coefficients and an altitude f 70 km, mutual neutralization will proceed with a time constant of he order of 1 sec, consistent with the observed short life time of ype-B aurora. The observed enhancements of the first negative ystem of O_2^+ and of sodium "D" are also postulated as resulting rom the penetration of an energetic beam of electrons to the 0-90 km level of the D-region. A monoenergetic beam of electrons nd protons of 240 keV is compatible with the elevations of homo- eneous arcs and type-B aurora. Other possible excitation mechan- sms for type B are discussed.

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14281 SPECTROSCOPIC OBSERVATIONS OF THE GREAT AURORA OF 10 FEBRUARY 1958. I. ABNORMAL VI- RATION OF N_2^+. K.C.Clark and A.E.Belon.
, atmos. terrest. Phys., Vol. 16, No. 3-4, 205-19 (Nov., 1959).

Auroral spectrograms taken with the IGY patrol spectrograph at ollege, Alaska, during the great aurora of 10-11 February 1958, how high vibrational excitation in the B($^2\Sigma_u^+$) state of N_2^+, as indi- ated by the enhanced intensities of the 4652 A (1,3) and 4600 A (2,4) ands relative to the 4709 A (0,2) band of the first negative system. he grating spectrograms presented consist of 18 successive expo- ures throughout the night from 0308 to 1529 hours UT 11 February nd resolve the magnetic meridian from North to South along the ength of the slit image. Intensity ratios are compared with those of ynthetic spectra at the same 8 A resolution calculated assuming oltzmann distributions at various excitation temperatures of vibra- ion and rotation. The excitation can in this manner be roughly haracterized by T(vib) = 4000° K and T(rot) = 2500° K. the enhance- nent is frequently so strong as to reverse the normally decreasing rder of intensities of the (0,2) and (1,3) bands. Unusually intense mission from hydrogen is frequently present, and the measured oppler shifts of H_α indicate velocities up to at least 800 km/sec. hese auroral measurements lend observational support to the con- ept that charge exchange becomes a major process in great urorae.

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14282 SPECTROSCOPIC OBSERVATIONS OF THE GREAT AURORA OF 10 FEBRUARY 1958. II. UNUSUAL TOMIC FEATURES. A.E.Belon and K.C.Clark.
. atmos. terrest. Phys., Vol. 16, No. 3-4, 220-7 (Nov., 1959).

Auroral spectrograms taken with the IGY patrol spectrograph at College, Alaska, during the great red aurora of 10-11 February 1958, show a large number of seldom seen atomic lines. Most of these enhanced emissions are identified as transitions of O I and N II. In particular, the identification of both low level forbidden lines of N II at 5755 A and 6584 A definitely establishes their presence in the auroral spectrum. Relative intensities of the auroral atomic emissions in three representative spectra are given and are compared with their intensities in a normal intense aurora. The unusual intensities and spatial behaviour of some emissions are discussed in terms of their excitation mechanisms

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14283 NOTE ON AIRGLOW TEMPERATURE DETERMINATIONS FROM OH SPECTRA. L.Wallace.
J. geophys. Res., Vol. 65, No. 3, 921-3 (March, 1960).

It is shown that the use of the approximate energy relation $F(J) \cong B_v J(J+1)$ in the determination of OH airglow rotational temperatures causes the temperatures determined from the P_1 branch to be about 8% too large. Corrections are applied to the previously determined temperatures.

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14284 A STUDY OF THE LATITUDE DEPENDENCE OF OH ROTATIONAL TEMPERATURES FOR CANADIAN STATIONS. D.H.McPherson and A.V.Jones.
J. atmos. terrest. Phys., Vol. 17, No. 4, 302-8 (Feb., 1960).

Spectra of the 6,2 and 5,1 OH rotation—vibration bands have been obtained at Saskatoon, Churchill and Resolute Bay over the period of 1957-1958. Rotational temperatures have been derived from the spectra. The mean temperatures obtained at the stations were: Resolute Bay (February-March 1957) 296° K; Saskatoon (February-March, 1957) 227° K; Churchill (March, 1958) 246° K; Saskatoon (April-May, 1958) 227° K. The results were consistent with the latitude effect detected by Chamberlain and Oliver (Abstr. 6333 of 1953). There appears to be a significant but unexplained difference between the 1957 and 1958 Saskatoon results.

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14285 AIRGLOW OBSERVATIONS ON BOARD THE "SOYA", JAPANESE EXPEDITION SHIP TO ANTARCTIC. M.Huruhata and J.Nakamura.
Rep. Ionosphere Res. Japan, Vol. 11, No. 2, 35-40 (June, 1957).

On board the "Soya", expedition ship to the Antarctic, airglow observations were made from November, 1956 to April, 1957, during her voyages from Tokyo to Cape Town and back. The zenith intensities of λ5577 line were compared with the fluorescent surface of radium paint and were calibrated with the photometer of the Tokyo Astronomical Observatory. The results show that the latitude dependence of intensity seems to be real, having the minimum intensity around the equator. The tendency at the middle latitude is still ambiguous.

551.5

14286 ON THE LATITUDE EFFECT OF AIRGLOW INTENSITY. H.Tanabe and T.Tohmatsu.
Rep. Ionosphere Res. Japan, Vol. 11, No. 3, 145-8 (Sept., 1957).

A short note of observations made at four stations by scanning photoelectric photometers furnished with interference filters isolating the 5577A radiation.

551.5

14287 RESONANCE SCATTERING BY ATMOSPHERIC SODIUM. VII. MEASUREMENT OF THE VERTICAL DISTRIBUTION IN TWILIGHT. H.N.Rundle, D.M.Hunten and J.W.Chamberlain.
J. atmos. terrest. Phys., Vol. 17, No. 3, 205-19 (Feb., 1960).

For Pt VI see Abstr. 2031 of 1960. The difficulty of determining the distribution of sodium from the usual integral equation for the brightness of twilight is discussed. It is found that the first derivative of this equation is much more suitable. An approximate solution in matrix form is derived and tested. The effect of resonance absorption on such calculations is considered and found to be slight for the lower range of total abundance encountered in practice, but not for the higher. A method of measuring the derivative with respect to shadow height of the twilight brightness is described: the field of view of a birefringent photometer is rotated around the zenith in a small circle and the resulting modulation recorded. Electrical compensation makes the instrument highly insensitive to scattered white light. The twilight emission may be followed right into the night airglow. Distributions are found for four runs made under rather poor conditions. They are similar to previous results but show more detail.

551.5

14288 PHOTOMETRIC OBSERVATIONS OF THE TWILIGHT GLOW [O I] 5577 AND [O I] 6300. L.R.Megill.
J. atmos. terrest. Phys., Vol. 17, No. 4, 276-85 (Feb., 1960).

The enhancement of both the [O I] 5577 and the [O I] 6300 atmospheric emission lines has been measured in detail for the night of 6/7 January 1958 at Rapid City, South Dakota. The enhancement of the 5577 emission cannot be explained on the basis of photo excitation alone. The 6300 emission is compared with recent theory. Fair agreement is noted between theory and observation.

551.5

14289 CONTAMINATION OF THE INTENSITIES OF THE OXYGEN LINES BY THE NEIGHBORING OH EMISSION BANDS IN THE NIGHT AIRGLOW. M.W.Chiplonkar and P.V.Kulkarni.
J. geophys. Res., Vol. 64, No. 10, 1641-2 (Oct., 1959).

It is suggested that the close wavelength equality between the 5593A(7,1) OH vibration—rotation band and the 5577A O I line and also between the 6257A(9,3) OH vibration—rotation band and the 6300 A O I line may be responsible in some part for apparent differences between the measurements of the heights of the emitting layers of the night airglow using broad band photoelectric photometers in the tropics (Poona) and in North America. It is suggested that in photometric measurements it is difficult to discriminate between the two green features and between the two red features.
R.W.Nicholls

551.5

14290 POLARIZATION OF LIGHT FROM NOCTILUCENT CLOUDS. G.Witt.
J. geophys. Res., Vol. 65, No. 3, 925-33 (March, 1960).

Measurements have been made in two spectral regions by a photographic technique. The photographs were taken at Torsta (63.3° N, 14.6° E) in central Sweden. The measured cloud features were selected from a cloud-covered area of the order of 10^5 km^2, and the exposures were made over a period of 3 hours. No significant variations were observed in time or space in the behaviour of the polarization. The particles forming the clouds may be of irregular shape. Since their orientation is likely to be random, it is reasonable to assume that they can be represented by spherical particles of comparable size. Following previous work (Tellus, Vol. 9, No. 3 365-71, Aug., 1957), the light is assumed to be singly scattered sunlight, and the Mie theory of scattering by spherical particles is applied in order to derive the particle radius from the observed polarization. For all observed scattering angles (20° to 60°) the degree of polarization was slightly less than that given by Rayleigh's law, and the values in the red wavelength region were found to exceed those in the blue. If the clouds are regarded as a monodisperse aerosol, comparison of the data with theoretically computed curves indicates that the radius of the particles ranges from 1.0×10^{-5} cm to 1.8×10^{-6} cm, depending on the refractive index assumed. For the more plausible assumption of a poly-disperse particle distribution the results indicate that no appreciable proportion of particles with radii larger than 2.4×10^{-6} cm can be present in the clouds. See also Abstr. 6484 of 1960.

551.5

14291 THE ABSOLUTE ZENITH INTENSITY OF [O I] 5577 AT COLLEGE, ALASKA. F.E.Roach and M.H.Rees.
J. geophys. Res., Vol. 65, No. 5, 1489-93 (1960).

The absolute zenith intensity of [O I] 5577 was measured over College, Alaska, at 5 minute intervals during nights from January 16 to April 8, 1959. A total of 3968 individual readings were obtained. The medium intensity is 2.40 kilorayleighs. 80% of the observations are included within the range from 0.74 to 11.5 kR. A general increase of 5577 intensity occurs with increasing geomagnetic activity.

551.5

14292 THE INTENSITY OF [O I] 5577 IN THE SUBAURORAL REGION AS A FUNCTION OF MAGNETIC ACTIVITY. F.E.Roach.
J. geophys Res., Vol. 65, No. 5, 1495-7 (May, 1960).

The intensity of [O I] 5577 at Fritz Peak, Colorado, and Rapid City, South Dakota, is found to increase with increasing planetary magnetic activity. The nature of the increase is similar to but smaller than that observed in the auroral zone.

551.

14293 A STUDY OF LOCAL GEOMAGNETIC INFLUENCE ON THE [O I] 5577 NIGHTGLOW EMISSION AT FRITZ PEAK. J.W.McCaulley, F.E.Roach and S.Matsushita.
J. geophys Res., Vol. 65, No. 5, 1499-1501 (May, 1960).

A comparison is made of (1) the horizontal magnetic intensity at Leadville, Colorado, and (2) the absolute zenith of [O I] 5577 at Fritz Peak, Colorado. The absolute zenith intensity of 5577 tends to increase as the magnetic ΔH becomes more negative.

551.

14294 A COMPARATIVE STUDY OF ABSOLUTE ZENITH INTENSITIES OF [O I] 5577.
F.E.Roach, J.W.McCaulley, E.Marovich and C.M.Purdy.
J. geophys. Res., Vol. 65, No. 5, 1503-11 (May, 1960).

The statistical distribution of the absolute zenith intensities of [O I] 5577 is compared for four locations at north geomagnetic latitudes 49°, 53°, 65°, and 88°. The distributions are similar in nature at all stations. The median values in rayleighs are 371 (49°) 251 (53°), 2400 (65°), and 630 (88°). The percentage occurence of intensities greater than the visual threshold is 2.2 (49°), 1.2 (53°), 83 (65°), and 15 (88°). Evidence is presented for and against a single excitation mechanism for both auroral 5577 and airglow 5577

551.

14295 THE INFRA-RED SPECTRUM OF THE NIGHT AIRGLO FROM 1.4 μ to 4.0 μ.
J.F.Noxon, A.W.Harrison and A.V.Jones
J. atmos. terrest. Phys., Vol. 16, No. 3-4, 246-51 (Nov., 1959).

The emission from the night airglow in the 1.4 μ to 4.0 μ region has been studied with a new infrared spectrometer. The 9.7 OH vibration—rotation band at 2.16 μ has been observed for the first tim and its relative brightness has been found to be somewhat lower tha has been predicted theoretically. Beyond 2.5 μ thermal radiation from the lower atmosphere becomes too bright to allow the detectio of further OH bands. The absolute brightness of the spectrum has been measured.

551.

14296 THE TRANSFER PROBLEM OF NIGHTGLOW AND ITS APPLICATIONS TO PHOTOELECTRIC PHOTOMETRY.
M.Huruhata and T.Tohmatsu.
Rep. Ionosphere Res. Japan, Vol. 11, No. 1, 11-16 (March, 1957).

Transfer problems of nightglow in the atmosphere are discusse A theoretical treatment of scattered light is attempted, applicable to an arbitrary height of the emitting layer, atmospheric conditions, albedo of the ground and height of the observing station. The result in the plane-parallel atmosphere are extended to the case of a spherical atmosphere. The numerical results are applied to the determination of the height of the O I λ5577 emitting layer. From the mean intensity in autumn and winter of 1953 to 1955 in Japan, it was found that the height of the layer would not exceed 150 km, and would probably be 100 km on average. The theories are also applie to the criticism of the "two-colour method" in photoelectric photometry. The conventional method of subtraction of background intens is allowed for ordinary observational conditions.

551.5 : 535.24

14297 RELATIVE ENERGY DISTRIBUTION OF DAYLIGHT FROM OVERCAST SKY. B.Hisdal.
Arch. Math. Naturvid., Vol. 54, No. 4, 10 pp. (1957).

Before any modification can be made to the adopted standard (C.I.E.) artificial-daylight source (1931) to further approximate its energy distribution to that of daylight it is necessary to find out the actual distribution from an average overcast sky at noon. The present investigation had this aim: and the results obtained from it are presented in graphical and tabular form. A plot is given of overcast-sky measurements at air-mass 1.5, covering the wavelength range, 3200 A to 6000 A. Also, C.I.E. chromaticity-coordinates, and colour-temperatures for the average energy distribution are tabulated for air-masses 1.2 and 1.5.
D.R.Barber

551.5

14298 CALCULATIONS OF ATMOSPHERIC INFRARED RADIATION AS SEEN FROM A METEOROLOGICAL SATELLITE. S.M.Greenfield and W.W.Kellogg.
J. Meteorol., Vol. 17, No. 3, 283-90 (June, 1960).

Since certain constituents (water vapour, ozone, carbon dioxide, etc.) of the atmosphere have pronounced absorption and emission bands in the i.r. region of the spectrum, the radiation which is radiated upward from the atmosphere will depend on the distribution and emperature of the constituents, and this radiation can be measured rom meteorological satellites. Sample calculations are given of ne emission by the water vapour in three wavelength intervals (at wo places in the strong absorption band, 6.0 and 6.2 μ, and in the egion of weak absorption, 8 to 13 μ). Water-vapour distributions sed in these calculations are those for the United States, measured y the University of Chicago and showing rather high stratospheric umidities; for the United Kingdom, measured by the Farnborough esearch Establishment and showing rather low stratospheric umidities; and for Swan Island, West Indies, where no humidity data ere available above about 10 km. It is shown that, for very strong bsorption by water vapour (as at 6.0 μ) and the United States humidty distribution, the upward emission originates mostly in the stratophere, whereas, for weaker absorption or lower stratospheric umidities, the upward emission comes mostly from below the tropoause. In the water vapour "window" at 8 to 13 μ, about two-thirds f the upward emission in the vertical comes from the ground in iddle latitudes (low humidities), but only about one-third of the urface radiation escapes in the tropics; i.e. the "window" is not at ll transparent.

551.5

14299 DETERMINATION OF LONG-WAVE ATMOSPHERIC RADIATION. F.F.Abraham.

J. Meteorol., Vol. 17, No. 3, 291-5 (June, 1960).

The total long-wave radiation flux measurements for eighteen nights are compared with the values obtained by using two types of radiation charts. It is found that the Suomi total radiometer yields values of the downward long-wave flux approximately 6% higher than the Beckman and Whitley total radiometer and 1% higher than the values calculated from the Elsasser radiation chart. The principal finding is that all of the approaches taken together suggest that existing radiometric data can be regarded as no more precise than about 5 to 10%.

551.5

14300 MEASUREMENTS OF INFRARED RADIATION DIVERGENCE IN THE ATMOSPHERE WITH THE OUBLE-RADIOMETER AND THE BLACK BALL. R.L.Aagard.

J. Meteorol., Vol. 17, No. 3, 311-18 (June, 1960).

A double-radiometer for measuring infrared radiation divergence in the atmosphere is described. Three soundings with this nstrument and the black ball are compared. General agreement xists between the radiometer divergence measurements and the ivergence computed from the black ball data. One sounding indiates that the atmosphere can be warmed by infrared radiation here the black ball is warmed above air temperature. An atmosheric emissivity has been computed from the radiometer data and ompared with the relative humidity.

551.5

14301 RADIATION MEASUREMENT ON THE ANTARCTIC SNOWFIELD, A PRELIMINARY REPORT. K.J.Hanson.

J. geophys. Res., Vol. 65, No. 3, 935-46 (March, 1960).

Observations of solar and terrestrial radiation and associated energy exchange at the geographic South Pole were first taken during the International Geophysical Year. An attempt is made to show the problems of radiation observation when standard instrumentation is used on a polar snowfield. Low sun elevation, temperatures 150° F below calibration, and human limitations during the winter night all affect in varying degree the observations of fluxes of solar and terrestrial radiation. A preliminary study of the radiant energy exchange is presented to show the absorption of solar radiation at the snow surface and the effect of "warm" clouds on surface temperatures during the winter night.

551.5 : 535.8

14302 INFRARED TRANSMISSION OF CLOUDS. D.M.Gates and C.C.Shaw.

J. Opt. Soc. Amer., Vol. 50, No. 9, 876-82 (Sept., 1960).

The i.r. transmission from 0.48 to 12.0 μ of various cloud types, ncluding cirrus, cirrostratus, altocumulus, altostratus, and cumulus re reported. The measurements were made using the sun as a source and directing the sunlight into a Perkin-Elmer i.r. spectrometer. The transmission is consistently slightly higher in the .0 to 12.0 μ region than in the 0.48 to 5.0 μ region. Calculations f the scattering coefficient for nonabsorbing spheres having the ensity and distribution of droplets found in clouds showed better ransmission at the shorter wavelengths than at the longer wavelengths. The difference between this and observation would appear o be due to the influence of the many water vapour absorption bands occuring in the near infrared. A possibility is given for distinguishing between ice crystal and water droplet clouds by means of the behaviour of 1.82 μ absorption band.

551.5

14303 CONTRIBUTION TO THE STUDY OF SILENT ZONES AND TO THE DISTANT FOCUSING OF SOUND.

J.Ecollan, J.Hieblot and Y.Rocard.

C.R. Acad. Sci. (Paris), Vol. 250, No. 22, 3605-7 (May 30, 1960). In French.

Investigations with sensitive instruments of the silent zones surrounding test explosions in France and the Sahara (including the nuclear explosion) suggest the existence of a second reflecting layer of 120 km altitude in addition to the known layer of 50 km altitude. High altitude winds may produce anomalous focusing effects.

T.S.E.Thomas

551.5

14304 STRUCTURE OF THE ELECTROSTATIC FIELD IN THE FREE ATMOSPHERE FROM THE RESULTS OF INVESTIGATIONS MADE DURING THE INTERNATIONAL GEOPHYSICAL YEAR. I.M.Imyanitov and E.V.Chubarina.

Dokl. Akad. Nauk SSSR, Vol. 132, No. 1, 104-7 (May 1, 1960). In Russian.

Results of measurements at Leningrad, Kiev and Tashkent show that the spherical capacitor model is not valid. J.Hough

551.5 : 621.316.98

14305 A COMPARISON OF INTRACLOUD AND CLOUD-TO-GROUND LIGHTNING DISCHARGES.

N.Kitagawa and M.Brook.

J. geophys. Res., Vol. 65, No. 4, 1189-1201 (April, 1960).

Lightning discharges were investigated with high time-resolution equipment on both electric-field and electric-field-change meters. Analysis of the electrical records reveals that the late stages of intracloud discharges are very similar to those of cloud-to-ground discharges during the periods between successive return strokes (junction process) and during the period after the last return stroke (final process). In contrast, the initial portion of the field change of an intracloud discharge bears little or no resemblance to the initial portion of the leader field change of a discharge to ground. It is suggested that the difference in the initial breakdown characteristics results from variations in the relative populations of water drops and ice particles as they affect the internal impedance of the region of cloud where breakdown occurs. The difference in the initial field-change characteristics of intracloud and cloud-to-ground discharges is so distinct that from the first 10 ms of the electric-field-change record one can predict with over 95% certainty whether a discharge will reach ground or remain within the cloud.

551.5 : 621.316.98

14306 SOME ASPECTS OF LIGHTNING ACTIVITY AND RELATED METEOROLOGICAL CONDITIONS.

M.Brook and N.Kitagawa.

J. geophys. Res., Vol. 65, No. 4, 1203-10 (April, 1960).

Lightning statistics are used to define a thunderstorm activity index. The index is based upon (1) the total duration and (2) the frequency of occurrence of lightning discharges. It is suggested that the horizontal extent of a storm may be inferred from the shape of the frequency-distribution curve, whereas the mean duration of discharges is related to the vertical convective activity. The bipolar thunderstorm model of Holzer and Saxon [J. geophys. Res., Vol. 57, 207-16 (1952)] is extended to account for the occurrence of multiple discharges to ground. A relationship between the number of intracloud discharges and the total number of separate return strokes in ground discharges may be predicted from the model. Good agreement is found with the predictions in some, but not all, storms. Statistics are cited which suggest that the ratio of intracloud to cloud-to-ground discharges may reflect the type of storm (e.g. "frontal" or "local air mass").

551.5

14307 NOTE ON THE SPECTRUM OF LIGHTNING IN THE REGION 3670 TO 4280 A . L.Wallace.

J. geophys. Res., Vol. 65, No. 4, 1211-14 (April, 1960).

Examination of the near-ultraviolet lightning spectrum has revealed the presence of the CN violet bands and a large number of unidentified features in addition to confirming most of the previous identifications.

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14308 VISUAL CONFIRMATION OF THE JUNCTION PROCESS IN LIGHTNING DISCHARGES.

M.Brook and B.Vonnegut.
J. geophys. Res., Vol. 65, No. 4, 1302-3 (April, 1960).

Details are given of visual observations of cloud-to-cloud and cloud-to-earth paths of lightning when several thunderstorms were active at night near Socorro, New Mexico. The streamer was seen to move slowly upward to remote regions of the cloud between return strokes of multiple discharge to ground and before a new section was added to the channel of the previous stroke. More discharges to ground progress horizontally or inclined at 30° than from a new vertical column. Lightning strokes may thus often bridge individual convective cells and thus tap the electrical energy stored in a number of storm cells. The observations afford support to the slow junction field change quoted first by Malan and Schonland. R.S.Read

551.5 : 621.316.98

14309 LIGHTNING AND CHARGE STORAGE.

E.J.Workman, M.Brook and N.Kitagawa.
J. geophys. Res., Vol. 65, No. 5, 1513-17 (May, 1960).

An unusual lightning flash consisting of a record 54 current surges, of which 26 were leader-return-stroke combinations, and having a total duration of 2 sec, is described. The character of the lightning flash evidences a charge configuration of large extent, thought to consist of from 4 to 6 thunderstorm cells simultaneously active. The electric and photographic evidence indicates path lengths of approximately 9 km (20 000 ft) for the final strokes of the flash.

551.5 : 523.877

14310 TERRESTRIAL AND COSMICAL LIGHTNING DISCHARGES.

C.E.R.Bruce.
Rep. Brit. Elect. Res. Assoc., Rep. Z/T119, 8 pp. (1958).

The paper reviews and answers the criticisms which have been made of the writer's glow to arc transition theory of the lightning leader stroke (1941) and also criticizes the modifications of the theory which have been suggested. It is also shown that light may be thrown on the problems of electric field generation and breakdown in thunderclouds by a study of the corresponding phenomena in the atmospheres of the long-period variable stars and possibly even in the extra-galactic nebulae themselves.

551.5

14311 V.L.F. PHASE CHARACTERISTICS DEDUCED FROM ATMOSPHERIC WAVE FORMS.

A.G.Jean, W.L.Taylor and J.R.Wait.
J. geophys. Res., Vol. 65, No. 3, 907-12 (March, 1960).

The waveforms of the electric field of atmospherics recorded at four widely separated stations were analysed to yield the phase characteristics of radio waves at very low frequencies. It is indicated that the relative phase velocity for propagation to great distances is about 3% greater than c (velocity of light in a vacuum) at 4 kc/s. Above this frequency, it gradually decreases, being about 1% greater than c at 8 kc/s. The form of the dispersion curve is very close to that predicted by the mode theory.

551.5

14312 THEORY OF TRAPPING OF WHISTLERS IN FIELD-ALIGNED COLUMNS OF ENHANCED IONIZATION.

R.L.Smith and R.A.Helliwell.
J. geophys. Res., Vol. 65, No. 3, 815-23 (March, 1960).

A ray theory of whistler propagation in ducts is developed for the purpose of explaining discrete whistler components. By use of refractive index surfaces and a Snell's law construction, it is shown that the only feature of the electron distribution affecting the trapping conditions is the ratio of the electron density in the column to that of the background. In most practical cases the electron density in the column required for trapping must be greater than the background level. Under certain conditions, however, the density in the column must be less than the background level. Using the theory, it is found that the enhancement required for trapping increases markedly toward the equator, providing a possible explanation for reduced whistler occurrence at the lower latitudes.

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14313 TURBULENCE AT ALTITUDES OF 80-100 km AND ITS EFFECTS ON LONG-DURATION METEOR ECHOES.

J.S.Greenhow and E.L.Neufeld.
J. atmos. terrest. Phys., Vol. 16, No. 3-4, 384-92 (Nov., 1959).

The two theories of long-duration radio echoes from meteor trails based on scattering from an over-critically dense ionized column, and incoherent scattering from a trail rendered under-dense b small scale turbulence are compared. Examination of the characteristics of enduring meteor echoes shows that the incoherent scattering theory is untenable, if small scale turbulence with a time contact of only 0.4 sec is assumed to be present. All the phenomena observed during the lifetime of a long duration meteor echo are readil explained on the basis of multiple reflections from overdense trails. The time constant and scale of the smallest eddies at heights of 80-100 km are shown to be at least 30 sec and 30 m, respectively.

551.5 : 525 : 621.391.812.6

14314 IONOSPHERIC SCINTILLATIONS OF SATELLITE SIGNALS.

H.P.Hutchinson and P.R.Arendt.
Proc. Inst. Radio Engrs, Vol. 48, No. 4, 670-1 (April, 1960).

The scintillation of satellite-emitted radio signals has been observed using two different techniques, namely Doppler-shift frequency measurements and radio direction-finding. The results obtained using Doppler-shift measurements are given. Variations from a smooth Doppler-shift curve obtained during individual orbits give a measure of the frequency scintillation occurring and thus of the roughness of the ionospheric path between the satellite and the observer. As expected, these variations are a function of frequency, and they become less as the frequency is increased.
tails of the investigation are to be published later.

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14315 DIRECTIONAL OBSERVATIONS OF 5 kc/s RADIATION FROM THE EARTH'S OUTER ATMOSPHERE.

G.R.A.Ellis.
J. geophys. Res., Vol. 65, No. 3, 839-43 (March, 1960).

Low-frequency radio noise bursts associated with geomagnetic disturbances have been observed with a network of direction-finding receivers in south-eastern Australia during September and October 1959. Over a range of longitudes from 135°E to 155°E, 18 noise bursts came from apparent sources at latitudes greater than 42°S. On 8 occasions, isolated discrete noise sources with an average geographical size of 550 km were detected at latitudes between 34°S and 42°S.

551.5 : 523.1

14316 OBSERVATIONS OF UNUSUAL RADIOFREQUENCY NOISE EMISSION AND ABSORPTION AT 80 Mc/s.

H.J.A.Chivers and H.W.Wells.
J. atmos. terrest. Phys., Vol. 17, No. 1-2, 13-19 (1959).

Unusual radiofrequency noise emissions at 80 Mc/s have been identified during periods of solar activity. The noise enhancements may be classified as (1) smooth, bay-like disturbances lasting for approximately 1 hr which occur in both day and night hours, and (2) abrupt increases, often of large but fluctuating amplitude which occu within a few hours of local midnight. The smooth enhancements occur almost simultaneously with the absorption of radiation in a sector of the northern sky. These effects could be caused by transit of high velocity streams of charged particles which produce emission from F-region levels and absorption in the E-region or below. The abrupt noise bursts at night are from the northern sky and seen to be associated with pronounced changes in the horizontal component of the earth's magnetic field. The noise may be a form of "auroral" radiation or may arise from propagation of solar noise outbursts from the sunlit to the dark hemisphere.

551.5 : 621.391.821

14317 A FOUR-YEAR SUMMARY OF WHISTLER ACTIVITY AT WASHINGTON, D.C.

H.E.Dinger.
J. geophys. Res., Vol. 65, No. 2, 571-5 (Feb., 1960).

Whistler and dawn chorus activity as recorded at Washington, D.C., during the period of July 1, 1955 to June 30, 1959 is tabulated and summarized. Of the 1461 days considered in this analysis, 94% had activity of some form. The equivalent of approximately five hundred 1800 ft reels of magnetic recording tape was analysed. The last 2 years of the period covered was part of the I.G.Y./I.G.C. Ionospheric Physics Programme.

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14318 RADIO SCATTERING IN THE LOWER IONOSPHERE.

H.G.Booker.
J. geophys. Res., Vol. 64, No. 12, 2164-77 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). Radio-scattering phenomena at the 80 t 90 km level observed in the frequency range 30 to 100 Mc/s indicat the presence of irregularities of electron density with scales in the ange from 20 to 60 m (corrugation wavelengths from 120 to 360 m). he irregularities are approximately isotropic, and the scattered ower is inversely proportional to about the sixth power of scale. he power law involved may, however, vary somewhat with the state f the atmosphere. The fading of the radio waves is consistent with andom motions of the irregularities with velocities of the order of 5 m/sec. Similar observations of the sporadic-E phenomena ccurring at a height of about 110 km show that the scattered power s inversely proportional to something like the eighteenth power of cale while the velocity of irregularities, if interpreted as random, s around 5 m/sec.

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14319 ATMOSPHERIC DIFFUSION AND NATURAL RADON. J.R.Philip.

. geophys. Res., Vol. 64, No. 12, 2468 (Dec., 1959).

It is pointed out that estimates of eddy diffusivity based on a teady state analysis of the natural radon concentration near the round have no validity and hence that an analysis of this form by ilkening (see Abstr. 8431 of 1960) must be considered unreliable.

C.Hazard

551.5

14320 THE EFFECT OF METEOROLOGICAL VARIABLES UPON THE VERTICAL AND TEMPORAL DISTRIBUTIONS F ATMOSPHERIC RADON.

.Moses, F.Stehney and H.F.Lucas, Jr.

. geophys. Res., Vol. 65, No. 4, 1223-38 (April, 1960).

Hourly values of radon concentrations were obtained simultaneusly at four levels above ground up to 39.9 meters on the Argonne leteorology Tower on three separate days. Twenty-seven consecuve hourly measurements were made on the first two days, and 17 n the third. Radon samples were obtained by adsorption on activated harcoal and were measured by means of scintillation counters. his technique, developed at Argonne, allowed direct measurement f radon instead of the common procedure of calculating radon values rom measurements of daughter products. The large amount of eteorological data routinely obtained at the Argonne Meteorology aboratory makes it possible to carry out detailed case studies on ne relationship between radon concentration and the meteorological ariables. This work has provided information on the heterogeneity the horizontal distribution of radon. An inverse fumigation phenoenon was also observed. Under very stable night time conditions ith light winds the radon concentrations observed at the top of the ower remained very low — about the same as during the daytime. hortly after sunrise, with an increase in verical mixing, the conentrations rose sharply. At a height of about 5.72 meters the radon oncentrations on the clear nights were larger by a factor of 20 than oncentrations on the clear days. During cloudy conditions night me values were about twice as large as day time values.

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14321 RADIOISOTOPES P^{32}, Be^{7}, AND S^{35} IN THE ATMOSPHERE. D.Lal, Rama and P.K.Zutshi.

. geophys. Res., Vol. 65, No. 2, 669-74 (Feb., 1960).

Simultaneous determinations were made of the concentrations f the radioisotopes P^{32}, Be^{7}, and S^{35} in several rains collected at ombay during the monsoon period of 1958. The observed annual eposition rates of P^{32} and Be^{7} are found to agree within the expected eteorological fluctuations with those measured in the preceding two ears at Bombay and other stations in India. S^{35} deposition, however, as varied significantly outside normal fluctuations. From the bserved variations in the annual fallout of these isotopes during 956-1958 and relative isotope concentrations in individual rains, it as been concluded that nuclear weapons have not resulted in any appreciable contributions to the observed Be^{7} and P^{32} activities. However, S^{35} was contributed in appreciable quantities. During 1958, S^{35} concentrations were very large, amounting to as much as 35 per cent of the observed Sr^{89} concentrations in some rains. The relative concentrations of the isotopes Be^{7} and P^{32} in rains vary in a manner that would be expected for their production in the troposphere by cosmic rays, and their removal by wet precipitation with an average removal period of about 40 days. None of the rain samples analyzed so far could have resulted in precipitation occurring from an air mass which descended in the troposphere after an irradiation in the stratosphere for time periods that are long compared with the half-lives of the isotopes.

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14322 RADIOCHEMICAL ANALYSES OF FISSION DEBRIS IN THE AIR ALONG THE 80th MERIDIAN, WEST.

L.B.Lockhart, Jr, R.A.Baus, R.L.Patterson, Jr and A.W.Saunders, Jr.

J. geophys. Res., Vol. 65, No. 6, 1711-22 (June, 1960).

A number of radioisotopes formed in high yield by nuclear explosions have been determined quantitatively in the gross-fission-product conglomerate collected by air filters at sites along the 80th meridian during the I.G.Y. Radiochemical analyses have shown that debris from two (or more) nuclear tests of the U.S. Hardtack Series in the Pacific crossed the equator. Save for the period of gross contamination in the troposphere by Hardtack debris, the average age of the fission-product conglomerate in the air has been consistently older in the southern than in the northern hemisphere. Furthermore, the Sr^{90} content of the air has shown a general pattern of maxima in the region between latitudes 20° and 40° N and between latitudes 20° and 40° S and a minimum in the equatorial region. During early 1958 the maximum in the north averaged about 7 times that in the south. The rapid spread of radioactivity from the Hardtack tests (identified by the presence of W^{185}) and from Soviet nuclear tests emphasizes the fact that debris is not restricted to a narrow zone near the latitude of introduction.

551.5 : 539.17

14323 NUCLEAR FISSION IN THE EARLY HISTORY OF THE EARTH. P.K.Kuroda.

Nature (London), Vol. 187, 36-8 (July 2, 1960).

It is suggested that at least a part of the heavier isotopes of Xe in the earth's atmosphere are fissiogenic, in particular that the abnormally high yield of Xe^{132} might be due to the spontaneous fission of some of the extinct trans-uranium elements.

S.J.St-Lorant

551.5 : 539.16

DETECTION OF RECENTLY PRODUCED FISSION PRODUCTS IN THE ATMOSPHERE. See Abstr. 11330

551.5 : 539.16

USE OF LONG-LIVED NATURAL RADIOACTIVITY AS AN ATMOSPHERIC TRACER. See Abstr. 13164

551.5

14324 ON THE COALESCENCE BETWEEN PLANE SNOW CRYSTALS. K.Higuchi.

J. Meteorol., Vol. 17, No. 3, 239-43 (June, 1960).

The calculation of the probability of coalescence between two plane snow crystals is described in detail. As the result of calculation, it was concluded that this probability is minimum when two crystals are of the same size, the probability increasing with the difference in size. Being concerned with the distance between the centres of two combined plane crystals, it was found that the most probable value was about a quarter of the sum of the diameters of two crystals.

BIOPHYSICS · PHYSIOLOGICAL PHYSICS

576.3

14325 A HIGH-DEFINITION AUTORADIOGRAPHIC STUDY OF AMITOTIC PHENOMENA AND NUCLEAR FRAGMENTATION WITH PENETRATING β-ACTIVE TRACERS AND USING THIN EMULSIONS. C.Gillet, R.Smeers and L.Winand.
Bull. Soc. Roy. Sci. Liège, Vol. 29, No. 5-6, 113-18 (May-June, 1960).
In French.

Describes in considerable detail the preparation of histological specimens for autoradiographic study with β-active P^{32}. Methods of coating the specimens with emulsion are suggested and the technique of developing such thin composite emulsion films discussed. A formulary of the developing and fixing baths required is appended.
S.J.St-Lorant

61 : 621.389

14326 MEDICAL ELECTRONICS. SECOND INTERNATIONAL CONFERENCE, PARIS, 24-27 JUNE, 1959.
Edited by C.N.Smyth.
London: Iliffe and Sons (1960) 614 pp.

The Proceedings contains the full text of 80 papers presented at the Conference, and abstracts of 64 more. They are grouped into 8 chapters: Electrophysiological techniques; Electroencephalography; Cardiology; Manometry and flow measurement; Acoustic techniques; Automation in medicine; Radiology and isotopes; Chemical instrumentation. Abstracts of some of the articles will be found in subsequent issues of "Physics Abstracts".

61 : 539.16

RADIATION PROCESSING OF FOODS. See Abstr. 13165

Hearing . Speech

612.7

14327 A METHOD FOR THE CALCULATION OF THE SPEECH INTELLIGIBILITY UNDER CONDITIONS OF REVERBERATION AND NOISE. J.H.Janssen.
Acustica, Vol. 7, No. 5, 305-10 (1957).

The method uses the concepts of useful speech level (i.e. maximum level of the speech signal reached within 50 msec after the arrival of a speech pulse front at the ears of the listener), reverberant speech level (i.e. maximum level in the reverberation period exclusive of the first 50 msec), the disturbing (random) noise level, the reverberation time (each of them in the five octave bands from 150 to 4800 c/s) and the articulation index. Results from measurements with and without headphones, in an anechoic room, in a reverberation chamber and in churches and theatres are compared with values predicted with the aid of the method; the agreement is satisfactory. The design of speech communication systems under reverberant and noisy conditions is facilitated.

612.7

14328 AMERICAN ENGLISH PHONEMES. E.P.Hamp.
J. Acoust. Soc. Amer., Vol. 32, No. 8, 1079-80 (Aug., 1960).

For earlier work see Abstr. 11969 of 1959. In order to be useful as a basis for frequency tables for American English phonemes, retranscriptions of existing word lists must take account of recent advances in phonemic theory as applied to the study of American English structure, and must be based on freshly recorded utterances representing a significant number of important dialect varities. Routine assignment of the traditional IPA symbols is inadequate.

612.7

14329 "ON AMERICAN ENGLISH PHONEMES". J.V.Tobias.
J. Acoust. Soc. Amer., Vol. 32, No. 8, 1080 (Aug., 1960).

A reply to the preceding abstract by the author of the original letter (Abstr. 11969 of 1959).

612.7

14330 THE SUBJECTIVE MASKING OF SHORT TIME DELAYED ECHOES BY THEIR PRIMARY SOUNDS AND THEIR CONTRIBUTION TO THE INTELLIGIBILITY OF SPEECH. J.P.A.Lochner and J.F.Burger.
Acustica, Vol. 8, No. 1, 1-10 (1958).

When interpreting intelligence conveyed by speech in a room the human hearing mechanism uses two distinct procedures; (1) it fixes direction by considering only the first pulses of direct sound and the difference in their time of arrival at the two ears; for this purpose the echoes reflected by the different room surface are effectively masked by the direct sound; (2) it interprets the message by integrating all the sound energy reaching the ears withi a certain time interval; in this procedure the direct sound frequentl plays a minor role, the major energy coming by way of reflections. A d cription is given of experiments carried out under nonreverberant conditions on the masking of single echoes by their primary sounds using speech and pulsed tones as signals. Results are given of articulation tests carried out to determine the integration characteristics of the hearing mechanism for speech.

612.8

14331 AN ARTIFICIAL EAR FOR INSERT EARPHONES. J.Y.Morton.
Acustica, Vol. 8, No. 1, 33-6 (1958).

The artificial ear is designed to have the mean acoustical impedance of 19 normal ears. It includes an ear-mould simulator, physical representation of the ear-canal, and acoustical elements to represent the ear-drum impedance. One of these elements is a series acoustical resistance.

612.8

14332 AN EXPERIMENTAL PITCH INDICATOR FOR TRAINING DEAF SCHOLARS. F.Anderson.
J. Acoust. Soc. Amer., Vol. 32, No. 8, 1065-74 (Aug., 1960).

An instrument is described which extracts from the complex speech wave, as produced by the deaf child or its teacher, information related to the subjective pitch of the sound. It then displays this information on the long-persistence screen of a revolving cathode-ray tube in such a manner that a continuous graph of pitch versus time is obtained. The deaf child is, therefore, enabled to compare visually the pitch patterns produced by the teacher and to correct defects in the pitch changes, rhythm, and phrasing of his speech. An experimental model of this instrument is being used successfully, but some deficiencies exist which require further study before an improved design can be finalized.

612.8

14333 THE DIFFERENCE BETWEEN THE CURVES OF EQUAL LOUDNESS IN THE PLANE WAVE AND IN THE DIFFUSE SOUND FIELD. G.Jahn.
Hochfrequenztech. u. ElektAkust., Vol. 69, No. 4, 75-81 (April, 1960
In German.

The influence of sound-field form on the subjectively determined loudness was measured objectively. Diffuse and plane-wave sound fields were compared. A probe microphone is described whic can be used to determine the sound levels in the ear passage up to the ear drum and these sound levels (objective) compared with the subjective loudness estimated by the observer. Curves are shown indicating the difference between the sound level at the ear drum and in the undisturbed sound wave (plane or diffuse) as a function of frequency in the range 400 to 10 000 c/s. The difference between the sound level at the ear drum and at the entrance to the ear passag is also shown as a function of frequency in this range. Below 5.5 kc/s the difference between the observed values for plane waves and diffuse sound, is less than ±3 dB. At 10 kc/s the difference may reach 10 dB.
A.B.Wood

612.8

14334 THEORY OF TEMPORAL AUDITORY SUMMATION. J.Zwislocki.
J. Acoust. Soc. Amer., Vol. 32, No. 8, 1046-60 (Aug., 1960).

A theory of temporal auditory summation is developed and applied to the threshold of audibility for various temporal patterns of pulses and sinusoidal vibrations. The theory is based on the assumption of an exponential decay of neural excitation and, for the threshold of audibility, it includes only one time constant. Various factors that may affect temporal auditory summation are discussed. It is shown that the same theory applies to muscle contractions.

612.8

14335 NORMS OF THE BINAURAL AUDITORY THRESHOLD IN A FREE FIELD. H.Gavini.
Acustica, Vol. 7, No. 5, 293-8 (1957). In French.

Study of the auditory threshold in a free field for pure tones etween 250 and 14 000 c/s, made under analogous conditions to those ata which served for the setting up of norms by Sivian and White Abstr. 3722 of 1933). Although the values for the mean threshold t various frequencies are near to those obtained in the U.S.A., ney tend to be lower at 250 and 500 c/s and higher at 2000, 12 000 nd 14 000 c/s.

612.8

14336 DETERMINATION OF THE HEARING THRESHOLDS OF NAVAL RECRUITS IN TERMS OF BRITISH AND MERICAN STANDARDS. J.J.Knight and R.R.A.Coles.
. Acoust. Soc. Amer., Vol. 32, No. 7, 800-4 (July, 1960).

A group of 111 naval recruits was examined in order to establish reference hearing level against which to assess the effects of noise xposure in serving men. The pure-tone thresholds were taken in a uiet ordinary room with a commercial audiometer. After exclusion f some subjects for reasons given, the thresholds of the main group f 74 men were analysed Precautions taken to insure constancy of erformance of the audiometer are described and its calibration was btained relative to both the appropriate British and American tandards. The results of the survey showed good agreement with he British standard as regards the main group and additionally for group of 15 men selected for minimal exposure to gunfire (less than even rounds of small-arms fire). A comparison was made with the earing level of a small group of more experienced listeners when an mprovement of about 2.5 dB was found. The relation of the work to ther hearing surveys and laboratory measurements is discussed.

612.8

14337 TEMPORAL SAMPLING PARAMETERS OF INTERAURAL NOISE CORRELATIONS. I.Pollack.
. Acoust. Soc. Amer., Vol. 32, No. 7, 795-99 (July, 1960).

The minimal interaural noise correlation discriminable by rained listeners was examined as a function of temporal sampling arameters of the noise. The prime determinant of the listeners' erformance is the total integrated duration of the noise samples, rrespective of the other temporal parameters. Within the restricon of a constant integrated duration, superior performance is ttained with an interval of about 2 msec between successive brief oise samples.

612.8

14338 NOTE ON THE EQUALIZATION AND CANCELLATION THEORY OF BINAURAL MASKING LEVEL IFFERENCES. N.I.Durlach.
. Acoust. Soc. Amer., Vol. 32, No. 8, 1075-6 (Aug., 1960).

Provides a brief introduction to a quantitative theory of inaural masking level differences. A model is proposed for the perations performed by the brain on the received signals and this odel is applied to some experimental data.

612.8

14339 DOES THE HYPOTHESIS OF THE HYDRAULIC FUNCTIONING OF THE COCHLEA BEAR ON THE EFINITION OF MASKING? M.F.Meyer.
. Acoust. Soc. Amer., Vol. 32, No. 8, 1076-8 (Aug., 1960).

Application of the theory of hydraulic functioning of the cochlea eads to a distinction between action of a tone upon another tone and ction of a noise upon a tone, and confirms the demand for a edefinition of masking.

612.8

14340 DETECTION OF SIGNALS OF UNCERTAIN FREQUENCY. S.D.Creelman.
. Acoust. Soc. Amer., Vol. 32, No. 7, 805-10 (July, 1960).

Theoretical models for frequency sensitivity in human observers re discussed. One decision procedure for a multiple-filter model s considered in some detail as a general model for decision situaons in which each available response is tied to more than one of the ossible signal alternatives. Two experiments were conducted in an ttempt to choose between a sweeping-filter model and a multiplelter model. Detection in a two-alternative forced-choice experient in which the signal could be one of two possible signals was easured over a range of frequency separations. The data yield rther support for a multiple-filter model.

612.8

14341 DETECTION OF A SIGNAL SPECIFIED EXACTLY WITH A NOISY STORED REFERENCE SIGNAL. T.G.Birdsall.
J. Acoust. Soc. Amer., Vol. 32, No. 8, 1038-45 (Aug., 1960).

Treats the optimization problem of detecting the presence of a signal in a background of white Gaussian noise, under the restriction that the signal is specified exactly but the receiver memory contains only a noisy version of the signal. The optimum receiver is specified. The performances of both the optimum receiver and the cross correlation receiver with a noisy memory are calculated and compared for a special case.

Vision

612.8

14342 NOTE ON MOBILE EYE VIEWPOINT RECORDING. B.Shackel.
J. Opt. Soc. Amer., Vol. 50, No. 8, 763-8 (Aug., 1960).

There are various ways of recording the eyeball position with respect to the head. If it is required to record the eyeball position with respect to the visual field, and thus to know the viewpoint at which the gaze is being directed, then the movements of the head and body, which displace the head datum-line with respect to the visual field, must be prevented or allowed for. Prevention satisfactorily permits static eye viewpoint recording. A practical trial is described of a method of allowing for head and body movements and thus providing mobile eye viewpoint recording. A motion picture or television camera upon the head records the immediate visual field and the viewpoint is marked by a superimposed white spot from the eyeball position recording apparatus. The records analysed cast some doubt on the usually accepted latency of coordinate compensatory eye movements.

612.8

14343 EFFECTS OF INVOLUNTARY EYE MOVEMENTS ON VISUAL ACUITY. U.T.Keesey.
J. Opt. Soc. Amer., Vol. 50, No. 8, 769-74 (Aug., 1960).

This research was conducted to evaluate the effect of involuntary eye movements on visual acuity. Three types of acuity target — vernier, fine line, and grating — were observed for varying exposure durations under two viewing conditions. One was the "stabilized image" condition where a mirror on the eye was used to reflect the target beam in such a way as to stop the motion of the retinal image that would otherwise accompany the eye movements. The other viewing condition was optically the same except that the eye movements produced normal motions of the retinal image. Acuity was defined in terms of a minimum angle of resolution, i.e., the threshold value of the angle subtended by the critical dimension of the target. Acuity was found to improve with increasing exposure time up to about 0.2 sec under both viewing conditions. The main conclusion is that acuity is neither enhanced nor impaired by the involuntary eye movements that are present during the inspection of a test object.

612.8

14344 MOVEMENT THRESHOLDS IN PERIPHERAL VISION. F.H.McColgin.
J. Opt. Soc. Amer., Vol 50, No. 8, 774-9 (Aug., 1960).

The absolute velocity thresholds of movement were determined at 48 positions in peripheral vision. An aircraft-type instrument, with a standard altimeter hand, was located at random positions on the concave, black surface of an 80 in. Fiberglas hemisphere. Four types of movement were investigated (clockwise and counter-clockwise rotation, vertical and horizontal motion) under conditions of constant photopic lighting. While the subject fixated on the centre point of the hemisphere, the absolute velocity threshold of each type of movement was determined for each position using the method of limits. Ten airline pilots served as subjects. The absolute threshold isograms on perimetric charts for both rotary and linear motion are elliptical in shape, with the horizontal axis approximately twice as long as the vertical axis. There is no difference between a subject's ability to see clockwise or counter-clockwise rotation. An individual's ability to perceive vertical motion is slightly better than his ability to perceive horizontal motion in the area adjacent to the horizontal axis. Velocity and area swept by the instrument hand are significant factors in the perception of movement, but they are not similarly correlated for all types of movement.

612.8

14345 FUSION OF COMPLEX FLICKER II. J.Levinson.

Science, Vol. 131, 1438-40 (May 13, 1960).

For Pt I, see Science, Vol. 130, 919 (1959). Flicker waveform has been found to have a slight but specific effect upon fusion threshold. A depression of threshold amplitude of about 30% occurs if a second harmonic of near-threshold amplitude is added to the fundamental. The magnitude of the depression depends critically on the relative phase of the two components of the waveform.

612.8 : 621.317.39 : 621.396.963

14346 EYE MOVEMENTS DURING SIMULATED RADAR SEARCH. C.T.White and A.Ford.

J. Opt. Soc. Amer., Vol. 50, No. 9, 909-13 (Sept., 1960).

The electrical method of eye-movement recording (the electro-oculogram) was utilized to study visual search behaviour while subjects monitored simulated radar displays. Information was obtained regarding the pattern of search employed, and the spatial distribution of fixations. These factors are discussed in regard to their effect on the detection of targets in displays of this kind.

612.8

14347 EYE MOVEMENTS RECORDED DURING CONVERGENCE AND DIVERGENCE. L.A.Riggs and E.W.Niehl.

J. Opt. Soc. Amer., Vol. 50, No. 9, 913-20 (Sept., 1960).

The purpose of the present experiments was to record horizontal binocular eye movements during normal amounts of convergence and divergence by a method having satisfactory sensitivity and accuracy. This is a method of direct photography, based upon collimated beams of light reflected from plane mirrors mounted on tightly fitting contact lenses. The records show that the eyes exhibit relatively rapid and accurate motions of vergence when fixating alternately a near and a far test object. There is no evidence for a systematic discrepancy between the extent of vergence and the geometrical location of the test object. It is concluded that when fusion is maintained, the images of a fixation object are brought to corresponding areas of the retina to an accuracy of about two minutes of arc. This finding is consistent with the reported sizes of Panum's area and the region of optimal visual resolution.

612.8 : 531.76

14348 WEBER RATIO FOR VISUAL DISCRIMINATION OF VELOCITY. R.H.Brawn.

Science, Vol. 131, 1809-10 (June 17, 1960).

As an approximation based on various experiments reported in the literature, the least detectable difference in speed ($\Delta\omega$) varies in direct proportion to the speed (ω) over a range from 0.1 to 20° of visual angle per sec. The constancy of the Weber ratio ($\Delta\omega/\omega$) aids in understanding how men react to velocity in various situations.

R.H Brown

612.8

14349 OVER COMPENSATION OF PERSPECTIVE DISTORTION OF SHAPE AND SIZE. E.Lau.

Optik, Vol. 17, No. 2, 84-9 (Feb., 1960). In German.

An object seen at varying obliquities appears subjectively to have a constant shape. It is shown that this phenomenal regression is sometimes excessive.

E.A.Mussett

612.8

14350 CONTRAST SENSITIVITY OF THE HUMAN EYE WITH DIFFERENT ILLUMINANTS. P.Jainski.

Lichttechnik, Vol. 12, No. 6, 355-9 (June, 1960). In German.

Measurements of the contrast threshold by binocular vision were made by a number of observers, using four illuminants and values of field luminance ranging from 0.01 to 600 asb. (0.001 to 60 ft-L). The four illuminants were (i) filament lamps, (ii) Na discharge, (iii) fluorescent and (iv) Hg colour-corrected lamps. There was little difference, except for (iii) which gave a rather higher sensitivity at lower values of luminance. The natural pupil was used.

J.W.T.Walsh

61

14351 STUDIES ON DARK ADAPTATION. V. EFFECT OF VARIOUS SIZES OF CENTRALLY FIXATED PRE-EXPOSURE FIELDS ON FOVEAL AND PERIPHERAL DARK ADAPTATION. J.A.Hanson, E.M.S.Anderson and R.P.Winterberg

J. Opt. Soc. Amer., Vol. 50, No. 9, 895-9 (Sept., 1960).

For Pt IV, see Abstr. 8452 of 1960. The effect of various siz of centrally fixated pre-exposures on foveal and peripheral dark adaptation was investigated. For both foveal and peripheral deter minations, absolute brightness sensitivity was measured monocularly with a 1° circular test patch. Peripheral locations tested were 2, 6, and 15° on the horizontal meridian of the temporal reti Foveal dark-adaptation curves were obtained after pre-exposure to fields which subtended 1, 2.5, 5, 10, and 37.5° diam. Periphera dark-adaptation curves were obtained for three sizes of pre-exposure field at each location. In the fovea, each size was prese at 1 ft lumen for 10 s, 100 ft lumen for 10 s, and 1000 ft lumen for 100 s. In the periphery, each size was presented at 0.1 ft lumen f 10 s and 10 ft lumen for 10 s. The foveal results, with one exception, indicated that size is not a differential factor. In the periphe the effects of size were most pronounced between those sizes whi did and those which did not stimulate the area tested.

61

14352 STUDIES OF DARK ADAPTATION. VI. EFFECTS ON FOVEAL DARK ADAPTATION OF SERIES OF ALTERNATING LIGHT AND DARK PERIODS.

J.A.Hanson, E.M.S.Anderson and R.P.Winterberg.

J. Opt. Soc. Amer., Vol. 50, No. 9, 900-2 (Sept., 1960).

This study investigated the effects on foveal dark adaptation of series of alternating light and dark periods. The purpose of th study was to determine the duration of dark period necessarily to avoid the cumulative effects of successive light periods on fove adaptation. Absolute brightness thresholds were measured monocularly. The test patch which subtended 1° diam, and the pre-exposure which subtended 37.5° diam were centrally fixated. Fov dark-adaptation curves were obtained after 10 and 25 presentatio of each of the following light and dark period combinations: (1) 1 ft lumen for 10 s with dark periods of 0, 10, and 25 s, (2) 10 ft l for 1 s with dark periods of 0 and 10 s, (3) 0.1 ft lumen for 10 s with dark periods of 0, 10, and 25 s, (4) 1 ft lumen for 1 s with da periods of 0 and 10 s, and (5) 0.1 ft lumen for 1 s with dark period of 0 and 10 s. Curves were also obtained after single presentatio of each light period. In most cases, the longest dark period durat tested appeared to minimize or cancel any cumulative effects the repeated presentations.

612

14353 RELATION BETWEEN DIRECTIONAL SENSITIVITY A SPECTRAL RESPONSE CURVES IN HUMAN CONE VISION. P.L.Walraven and M.A.Bouman.

J. Opt. Soc. Amer., Vol. 50, No. 8, 780-4 (Aug., 1960).

In human colour vision each incident spectral energy distribu is coded in three values, corresponding to the responses of the re green, and blue receptor systems. The Stiles—Crawford effect an the colour phenomena associated with it indicate that these three values are in a different degree for each wavelength dependent on eccentricity of the point of entry of the light in the pupil. A rather quantitative description of the facts is given by a theory in which leak factor of the light to the surrounding tissue in the outer and the inner segment is involved. The leak factor implies that for oblique light the effective pathway in the outer segment is shorten This results in narrowing of the fundamental response curve of th particular receptor. Theory strongly points to rather high densit of the photopigment in the receptor, but not improbably high. On the contrary, there is agreement with other sound suggestions and estimates of the density value. As absorption curves for the red, green, and blue pigments Pitt's curves were used. The agreement of different experimental data with this theory strongly supports the Young—Helmholtz hypothesis, as far as the receptor layer is concerned, and also indicates that the curves derived by Pitt are fairly good approximations of the absorption curves of the photopigments after correction for absorption of light by the ocular media.

612.8

14354 **SOME NEW ASPECTS OF COLOR STEREOSCOPY.** J J.Vos.

. Opt. Soc. Amer.; Vol. 50, No. 8, 785-90 (Aug., 1960).

By the term colour stereoscopy is meant that the colour of n object has an influence on its apparent distance in binocular erception. It is usually explained in terms of the chromatic berration of the eye, together with the eccentric position of the ovea. It is shown that this theory only partly explains the pheno- enon and that the misorientation of the retinal receptors - as becomes manifest in the Stiles—Crawford effect - must have n equivalent infuence. A complete experimental verification met evere difficulties which have only partly been overcome. Never- heless, it has been proved that this "Stiles—Crawford component" s of the same order of magnitude as the original "visual axis- omponent". Since both components seem to work antagonistically, can be easily explained why so many subjects see blue in front f red objects instead of the reverse.

612.8

14355 **TWO-COLOUR PROJECTION PHENOMENA.** M.H.Wilson and R.W.Brocklebank.

. photogr. Sci., Vol. 8, No. 4, 141-50 (July-Aug., 1960).

Two-colour projection of the kind demonstrated by Land (see bstr. 3372-6 of 1960) is described in relation to earlier processes. he conditions necessary for the appearance of the surprisingly wide ange of colour are discussed, and it is shown that these can be roduced without recourse to "natural image situations". The nfluence of a number of factors is demonstrated. It is further shown hat the modern concept of adaptation, together with the known mbiguities of foveal vision, is sufficient to account for all these ffects. The inherent limitations of the two-colour method are emonstrated and the possibilities of two-colour and three-colour ethods are compared. Some aspects of Land's theory are dis- ussed and an evaluation of his work is attempted.

612.8

14356 **COLOUR AND COLOUR RENDERING OF LIGHT HAVING A CONTINUOUS SPECTRUM WITH SUPERPOSED SPECTRAL LINES.** H.W.Bodmann and E.Voit.

Lichttechnik, Vol. 12, No. 6, 359-61 (June, 1960). In German.

A number of familiar objects were viewed under light made up of standard illuminant A with the addition of various amounts of one of four spectral lines: 436, 546, 589 (Na) and 655 mμ. For equal energy, the 589 line was found to produce the least deterioration of colour rendering, while the green 546 produced the greatest. For equal light flux there was little difference between these two but the effect was much greater with the red and the violet lines. As regards the colour of the light it was found that tolerance was greatest for the 436 line. J.W.T.Walsh

612.8

14357 **EFFECT OF PREPARATION AND ELECTRODE PLACEMENT ON THE FROG E.R.G.** E.Dzendolet.

J. Opt. Soc. Amer., Vol. 50, No. 9, 903-8 (Sept., 1960).

Diffuse illumination was used to stimulate the in-place frog eye. The intact, essentially intact, and opened-eye preparations were used. With the intact eye, the electroretinogram (ERG) was detected by a ventrodorsal, craniodorsal, or caudodorsal electrode placement on the skin around the eye, but not by a craniocaudal, ventrocranial, or caudoventral placement. An asymmetrical electrode placement on the cornea, or placement of the reference on the cornea and probe on the skin or on an injured corneal section, also detected the EIRG. In the opened eye, only the ERG was detected with reference on the retina's vitreous side. With the reference on the cornea, the ERG was seen. In the essentially intact eye, with the probe entering from the choroidal side, only the ERG was observed with either a corneal or a choroidal reference. Two hypotheses were advanced. The first was the presence of an insulating layer, probably Bruch's membrane, in most of the eye except for the cornea which is insulated by Bowman's membrane. The second was that the EIRG is a complex waveform resulting from the ERG's entering both the probe and reference electrodes and summing algebraically if the insulating layer just mentioned were sufficiently disturbed.

TECHNIQUE . MATERIALS

62

14358 ULTRASONIC SURFACE CLEANING.
J.Olaf.

Acustica, Vol. 7, No. 5, 253-63 (1957). In German.

The conditions (especially those concerning the action of cavitation) for the cleaning of surfaces using ultrasonics in the frequency range from 15 to 2500 kc/s are investigated. Measurements were made on mechanically polished glass surfaces with variable sound intensity and direction, time of irradiation and liquid medium. The cavitation can be increased or hindered by changing the hydrostatic pressure. The choice of liquid and the onset of cavitation have a large effect.

62

14359 HIGH PRESSURE AND TEMPERATURE APPARATUS WITH CONICAL PLUNGERS.

L.F.Vereshchagin, V.A.Galaktionov, A.A.Semerchan and V.N.Slesarev.

Dokl. Akad. Nauk SSSR, Vol. 132, No. 5, 1059-61 (July 11, 1960). In Russian.

An apparatus is described for subjecting specimens of about 2.5 cm^3 in volume to pressures up to 70 000 kg/cm^2 and temperatures up to 2000° C. The pressure is created between the smaller ends of two truncated cones with their axes opposed; the special packing and the rings required for lateral strengthening are specified. Armco iron, melted at 70 000 atm and 2000° C, showed an appreciable increase in hardness after cooling. R.F.S.Hearmon

620.1

14360 HARD GALLIUM ALLOYS FOR USE AS LOW CONTACT RESISTANCE ELECTRODES AND FOR BONDING THERMOCOUPLES INTO SAMPLES. G.G.Harman.

Rev. sci. Instrum., Vol. 31, No. 7, 717-20 (July, 1960).

A new family of low contact resistance electrodes is described. These are hard alloys of gallium, prepared at room temperature in a manner similar to that of dental amalgams. They may be packed into cavities in semiconductors or in some cases applied to a flat surface and allowed to harden under pressure. These alloys can also be used to bond wires and thermocouples into samples. The maximum operating temperatures range from 250° to about 900° C for various alloys. The electrical characteristics, when used on ferrites and controlled valency semiconductors, are similar to tho of the frequently used semiliquid indium—mercury and indium—gallium electrodes.

620

14361 PRECISE AUTOMATIC INEXPENSIVE BURET READE
J.Farquharson.

Rev. sci. Instrum., Vol. 31, No. 7, 723-5 (July, 1960).

An instrument has been developed to find automatically the le of a colourless liquid in a glass tube and to indicate the volume on digital register. The instrument is applied to volumetric measurements required in a chemical titration. The first model has a ran of 40 ml, a precision of ±0.02 ml on a single determination (95% c fidence level), and a bias of 0.1%. A photocell detector with a cabl and drum elevating and measuring mechanical system is employed

621

14362 PRODUCTION OF ISLANDS AND DICE IN SEMICONDUCTOR SLICES WITH AN ULTRASONIC DRILL.

R.D.Knight.

J. sci. Instrum., Vol. 37, No. 8, 263-5 (Aug., 1960).

The production of islands of less than 0.002 in. in diameter wi an ultrasonic drill is described along with the tools and the additio made to the equipment to achieve the degree of accuracy required. A novel feature is a frictionless gauge to indicate depth and rate cutting. Also described is a method of bulk dicing and bulk islandi by the use of laminated tools. Each of these tools has a protrudin "pilot-blade" to locate the work so that dicing can be correctly related to islanding and/or to any strip plating, markings, etc., put on the slice in earlier operations. A novel self-aligning work table, essential to the bulk islanding process, ensures that the exposed face of the semiconductor slice is in intimate contact with the tool face.

669 : 539

AN ANALYTICAL APPROACH TO THE DIFFUSION BONDING PROBLEM. See Abstr. 13478

LIST OF JOURNALS

The following list supplements the List of Journals published with the Index to Volume 62 (1959). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d post free. The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Agric. horticult. engng Abstr.
Agricultural and Horticultural Engineering Abstracts. — British Society for Research in Agricultural Engineering, National Institute for Agricultural Engineering, Wrest Park, Silsoe, Beds.

Defence sci. J.
Defence Science Journal — Defence Research and Development Organisation, Ministry of Defence, Government of India, New Delhi.

Meteorol. geoastrophys. Abstr.
Meteorological and Geoastrophysical Abstracts (Formerly: Meteorological Abstracts). — American Meteorological Society, 45 Beacon Street, Boston, Mass.

NEW JOURNAL

Instn Engrs, Austral., elect. mech. Engng Trans.
Institution of Engineers, Australia, Electrical and Mechanical Engineering Transactions. — Institution of Engineers, Australia, Science House, Gloucester and Essex Streets, Sydney. Vol. 1, No. 1, dated May, 1959.

CHANGE OF TITLE

Meteorol. Abstr.
Meteorological Abstracts. — Title changed to: Meteorological and Geoastrophysical Abstracts (Meteorol. geoastrophys. Abstr.) with issue dated Jan., 1960.

ERRATA

Subject Index (1955) p. 1517, col. 1: Entries 1395 and 2344 under the heading "Double refraction, mechanical" to be transferred to the heading "Drops".
Subject Index (1955) p. 1517, col. 2: Entry 6970 under the heading "Drops" to be transferred to the heading "Double refraction, mechanical".
Abstr. 5107 (1957) line 3: for "Vol. 245" read "Vol. 243".
Abstr. 7784 (1957) line 3: for "Vol. 224" read "Vol. 244".
Author Index (1959) p. 1398, col. 1: lines 35-59 (thirteen entries, Gombas, P. to Goodman,L. and Frolen,L.J.) should be inserted alphabetically in column 1, lines 60 to end, and in column 2, lines 1 to 24.
Subject Index (1959) p. 1572, cols 1 and 2: The entries "diamonds 11633" and "graphite 10988" under the heading "Crystal structure, atomic, inorganic compounds" to be transferred to the heading "Crystal structure, atomic, elements".
Subject Index (1959) p. 1580, col. 2: Last entry under the heading "Deuterons, scattering" (Abstract 6278-9) to be transferred to the heading "Crystals, etching".
Abstr. 2924 (1960) line 3: for "B.M.Golobin" read "B.M.Golovin".
Abstr. 6577 (1960) line 4: insert "In Russian" at end of journal reference.
Abstr. 6620 (1960) line 9: for "10^9 and 10^{10} deg-K" read "10^8 and 10^9 deg-K".
Abstr. 7008 (1960) line 3: for "Vol. 41" read "Vol. 32".
Abstr. 7146 and 7147 (1960) line 3: for "I.M.Bronstein" read "I.M.Bronshtein".
Abstr. 7743 (1960) line 4: for "Vol. 55" read "Vol. 45"; for "No. 5" read "No. 7".
Abstr. 7851 (1960) line 13: for "cam/^{0}K atom" read "cal/^{0}Kg atom".
Abstr. 7852 (1960) line 16: for "cal/^{0}kg atom" read "cal/^{0}Kg atom".
Abstr. 7993 (1960) line 3: insert "In Russian" at end of journal reference.
Abstr. 8033 (1960) line 5: for "Vol. 41" read "Vol. 32".
Abstr. 8611 (1960) line 3: for "Ziemkiewicz" read "Zienkiewicz"
Abstr. 9186 (1960) line 15: for "Mz" read "M_Z".
Abstr. 9217 (1960): reference should read: Zh. tekh. Fiz., Vol. 29, No. 7, 815-18 (July, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 7, 736-9 (Jan., 1960).
Abstr. 9521 (1960) line 3: for "Sklyareskii" read "Sklyarevskii".
Abstr. 9882 (1960) line 3: for "J.F.Cotnwell" read "J.F.Cornwell".
Abstr. 10807 (1960) last line: for "transferring" read "heat-transferring".
Abstr. 11284 (1960) line 2: for "G.Briet" read "G.Breit".
Abstr. 11457 (1960) line 3: for "I.Bondarenko" read "I.I.Bondarenko"
Abstr. 11719 (1960) line 3: for "G.E.Zilberman" read "G.E.Zil'berman".
Abstr. 12019 (1960) line 3: for "F.Fujimato" read "F.Fujimoto".
Abstr. 12041 (1960) line 12: for "1.5$^{0/}$" read "1.5%".
Abstr. 13137 (1960) line 8: after "ground" insert "state".
Author Index (Feb., 1960): for "Denison,F.P." read "Denisov,F.P.".
Author Index (June, 1960): for "Speranskaka,N.I." read "Speranskaya,N.I.".
Author Index (July, 1960): after Sharvin,Yu.V: for "9934" read "8934".
Author Index (July, 1960): for "Döring,W., 10162" read "Döring,W., 10161".

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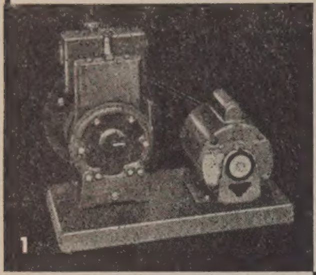

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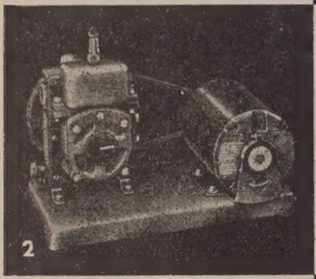

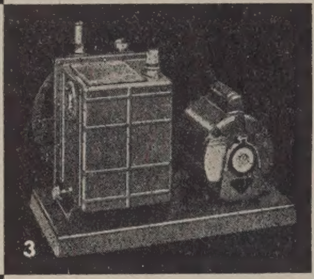

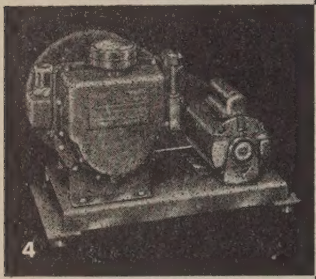

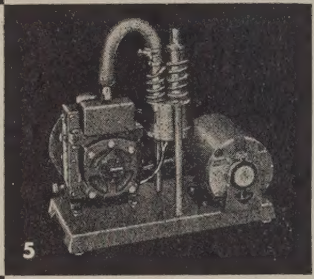

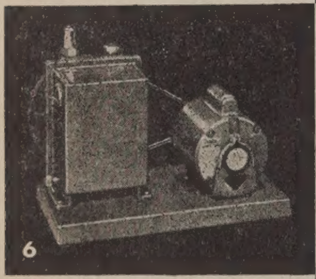

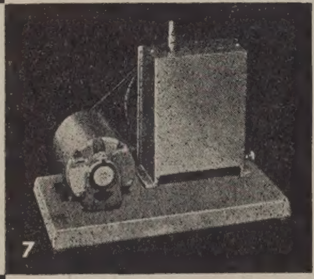

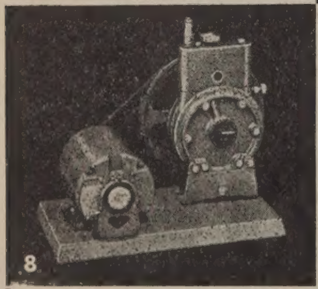

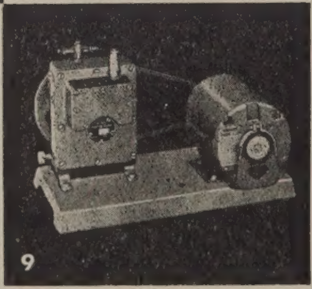

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